POWER

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Your Employer Will Know

DO you always manage to get busy on the approach of your employer? Do you ever refuse to work overtime and inconvenience yourself when it would mean a saving for your employer, on the ground that he would never know of it and you would get no credit for so doing?

Do you ever refuse to lend a helping hand to your brother in another department in emergencies, on the ground that the company would not thank you and that it can afford to put on extra help?

Concerning the first question, your employer knows whether or not your plant is operating satisfactorily, and if it is, and you have time to sit down and read or swap yarns with your associates, there is no reason to break and run like frightened sheep at his approach. When you do he must conclude either that you have been neglecting something or that you consider him your avowed enemy, both alike displeasing to any fairminded employer. If he is not such a one, then keep busy all the time (if that is what he desires) or seek another position, but never show any more signs of diligence in his presence than you would otherwise.

Regarding the other two questions, do not get the idea that your employer will never know of the extra things you do, large or small. Even though he did not, doing them will do you no harm but, on the contrary, you will gain experience; your conscience will feel satisfied because you turned a loss into profit, or made a friend by lending your assistance in time of need, and last but not least, you will form a commendable habit that will redound to your credit and benefit. A spirit of willingness to do, regardless of direct reward or appreciation, is the proper one and is bound to make you a better man and a better master of your profession.

[*Contributed by Joseph Stewart, Hamilton, Ohio.*]

Model Mixed-Flow Steam-Turbine Plant

By Warren O. Rogers

SYNOPSIS—Exhaust steam from 4000 hp. in reciprocating engines and five steam hammers, varying in size, is used to operate three 1250-kv.-a. horizontal steam-turbine generators, at 16 lb. pressure, absolute. The electrical energy developed from steam, which was formerly wasted, operates a maximum of 114 motors, a total of 2800 hp. The turbines run condensing. A high-pressure, 100-kw. turbine unit supplies electrical energy during periods when the larger units are not operating.

Since the founding of Henry Disston & Sons, Inc., Philadelphia, Penn., in 1840, many thousand pounds of water in the form of exhaust steam has been allowed to go to waste after passing through steam hammers and rolling-mill engines, as was, and still is, the practice in such works. From time to time new buildings were erected, and more machinery called for additional steam consumption, until the Disston works are now the largest of their kind in the world.

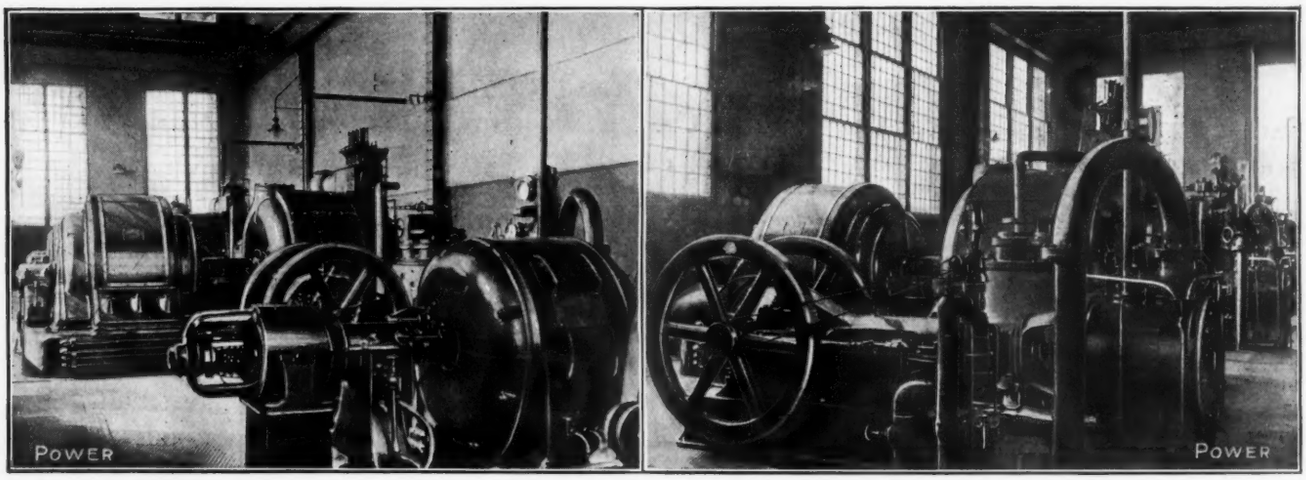


Fig. 1. Three 1250-Kw. Mixed-Pressure Steam Turbines

At present, the mill steam equipment consists of five steam hammers, varying in size, capable of striking blows of from 50 to 4500 lb., and 13 rolling-mill steam engines, with a total capacity of 4000 hp. The exhaust steam from these units approximates 60,000 lb. per hr., which formerly escaped to the atmosphere.

This, however, was before the mixed-pressure turbine had been developed. Now, all exhaust steam is piped to a receiver, but about 40,000 lb. per hr. is used in the turbines, which are installed in a separate power plant; the balance of the steam escaped to the atmosphere.

Turbine Units

In Fig. 1 is shown the three main, 1250-kw. mixed-pressure turbines, driving 1250-kv.-a. alternating-current generators at 1800 r.p.m. and delivering electrical energy at 2300 volts. The turbine room adjoins one of the rolling-mill buildings and is lighted by windows at both ends and the outside wall, as shown. The cream-colored walls also add to the lighting effect, and the dark-brown wainscoting gives a clean, attractive appearance.

The turbine units are placed crosswise, with the steam end next to the brick wall dividing the turbine room from the rolling mill. At the rear end of the room is a 100-kw. high-pressure steam turbine which generates 2300-volt alternating current at 3600 r.p.m.; a self-contained exciter set is mounted on the generator end of the shaft. At the same end of the room there are two direct-current exciter sets, each of 75-kw. capacity, at 125 volts. A 125-hp. induction motor drives one generator at 1200 r.p.m.; the other is driven by a 75-kw. single-stage horizontal turbine at 3300 r.p.m. This turbine runs noncondensing, but it is used only when all of the main turbines are shut down, and the small high-pressure turbine is not operating. This condition, however, has never obtained since the plant was put in operation on Apr. 21, 1913.

The slate switchboard consists of 15 panels; six are for controlling the motor circuits, four are generator panels, three are for the exciter control, one is devoted to instruments and one to control the induction-motor exciter unit. A 20-ton Niles crane travels the length of the turbine room, the floor of which is made of concrete.

Condensers

The four surface condensers are in the basement, directly beneath the turbine units. The three large condensers contain 5000 sq.ft. of 1-in. tubing. Circulating water is supplied to each large condenser by a 12-in. volute pump, driven by a 9x7-in. vertical steam engine, Fig. 2. At the time of the writer's visit the temperature of the circulating water was 54 deg. F.; that of the discharge water never differs more than 7 deg. F. A vacuum of 28 in. is carried. The dry-air pumps of each condenser, of the horizontal reciprocating type, are placed alongside the turbine on the turbine-room floor. A small surface condenser, Fig. 3, containing but 300 sq.ft. of cooling surface, is also in the basement and serves the

small 100-kw. turbine. The condenser is fitted with a reciprocating circulating-water and air pump with cylinders 6, 8 and 8 by 10 in. in size.

Each of the large condensers has a hotwell which is attached to the bottom of it. The water of condensation is taken from each hotwell by a 6 and 5¾ by 6-in.

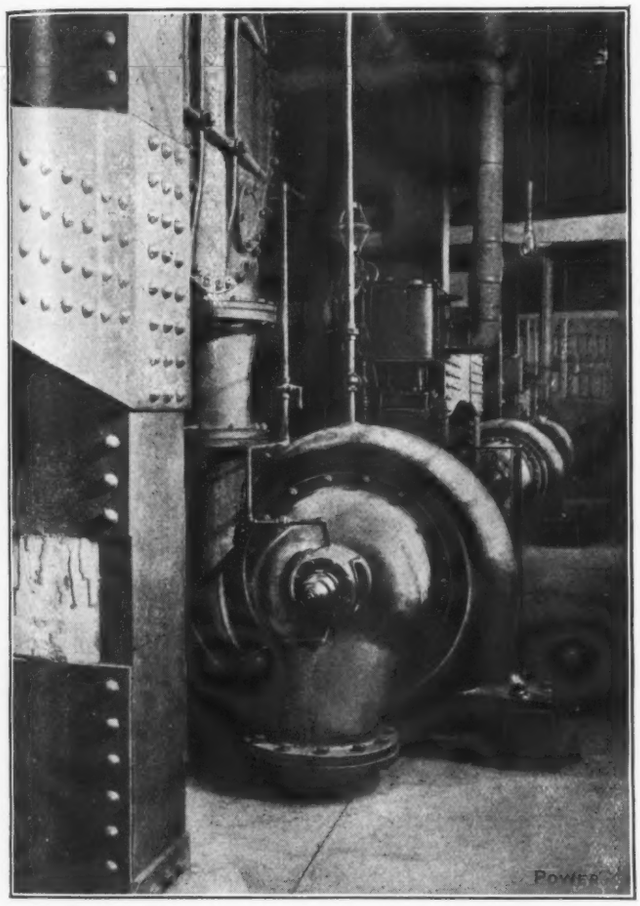


FIG. 2. ENGINE-DRIVEN 12-IN. VOLUTE CIRCULATING PUMPS

duplex pump and, after passing through a heater, is discharged to the boilers some distance away. This condensate at the present load on the turbines is approximately 40,000 lb. per hr., which represents the amount of steam that is now utilized in producing electrical energy from steam that was formerly wasted. Even under existing conditions 20,000 lb. of steam goes to the atmosphere, but some of it will be used in heating the buildings as soon as a suitable system has been installed.

A novel method of supporting the turbines has been employed. Under each unit eight concrete piles were set in the earth, and upon them a concrete block 5 ft. thick was placed. Upright pieces of channel iron rest on the concrete base and are filled in with concrete, as shown in Fig. 4; Fig. 5 is a detailed drawing.

When the plant was first installed, air for cooling the turbo-generators was taken from outside the building, but the basement became exceedingly hot and air for the generators was later taken from the basement and discharged outside of the building, though galvanized-iron air ducts. The volume of air used for cooling each generator is 10,000 cu.ft. per min.

At one end of the condenser room is a motor-driven 42-in. propeller fan used to draw the hot air from the basement. Fresh air is admitted through screened windows at the opposite end of the basement.

All steam and exhaust lines are drained into traps in the basement, all placed on a projection built on the inside wall, as in Fig. 6. There are four large steam traps on the low-pressure steam lines, four on the exhaust-steam and four on the live-steam lines. These traps drain into a 3-in. main and the condensate is conveyed to a hot-water heater and then pumped into the boilers. This arrangement of the traps is ideal for they are placed where they are easily inspected and yet are above the floor level out of the way of the operators.

PIPING

Exhaust steam is collected from the reciprocating mill engines, which are of various designs, by fitting each exhaust pipe with a three-way valve. When the valve is in one position the steam escapes to the atmosphere through the vertical pipe, shown in Fig. 7; when in the other, the steam passes to a main header leading to a receiver placed on the mill side of the turbine-room wall. The two exhaust-steam headers begin with an 8-in. pipe and increase in size as the exhausts from the various engines are piped into the main until the 28-in. receiver is reached. The two exhaust-steam lines enter the receiver from opposite

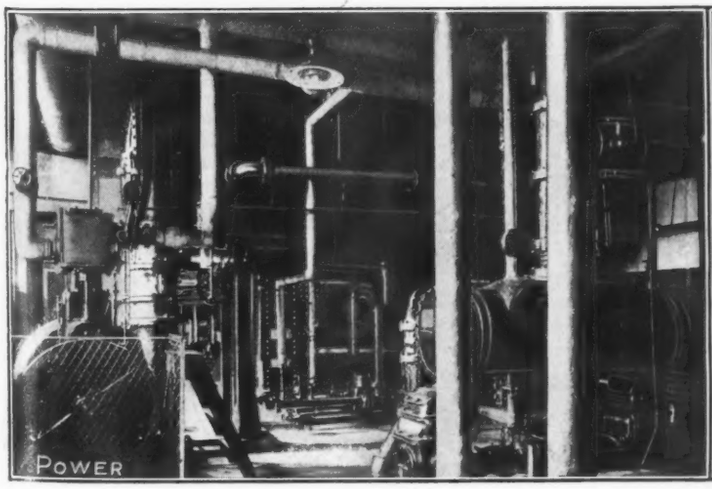


FIG. 3. PARTIAL VIEW OF THE SURFACE CONDENSERS IN THE BASEMENT

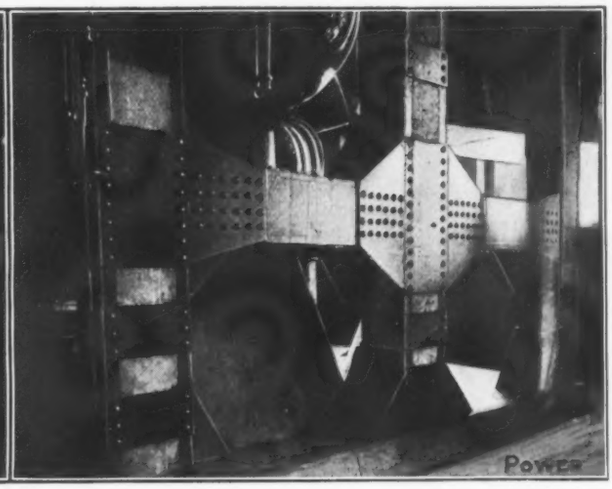


FIG. 4. TURBINE FOUNDATION OF CHANNEL IRON AND CONCRETE

directions, connecting at the two ends, as shown in Fig. 8.

To the upper side of the receiver a 28-in. back-pressure valve is connected, and is piped to the atmosphere. Back of the receiver is a live-steam main, which supplies each turbine with high-pressure steam through a 10-in. lead, lead to the three mixed-flow turbines. Each of these branch pipes contains a stop valve so that any one or all of the turbines may be cut out from the low-pressure header. These valves are operated by handwheels and horizontal shafts which extend through the turbine-room

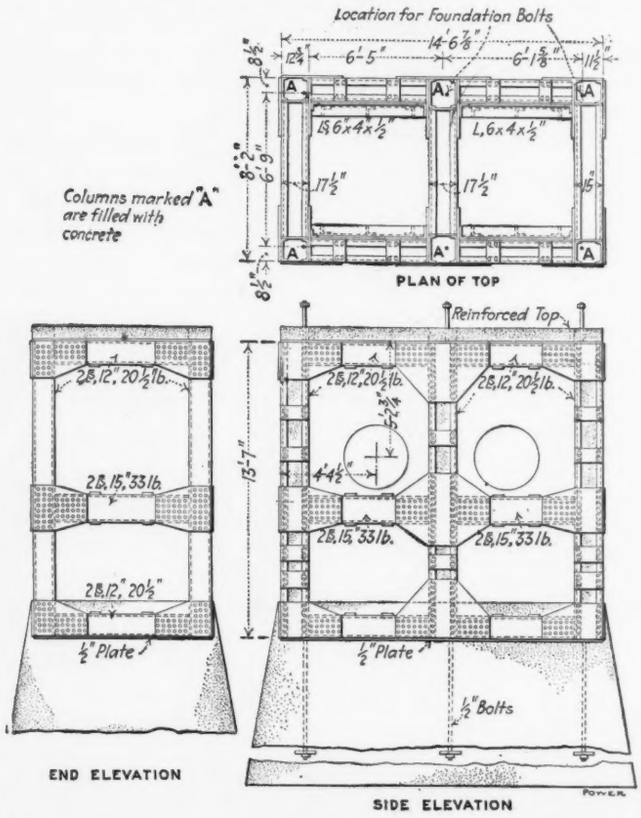


FIG. 5. DETAIL OF METAL CONSTRUCTION OF TURBINE FOUNDATIONS

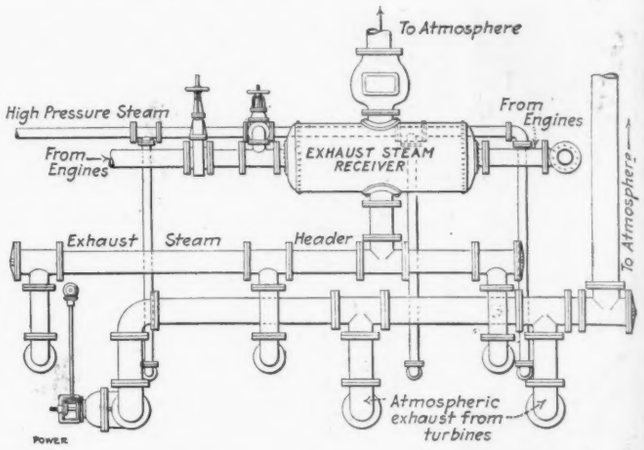


FIG. 8. RECEIVER, LINE AND EXHAUST-STEAM PIPING

wall. The other end of each shaft is fitted with a bevel gear which meshes with a similar gear on a vertical shaft, a gear on the lower end of which meshes with a similar gear on the valve stem.

In case it is desirable to operate the turbines noncondensing, a branch from the exhaust pipe of each is piped to a main header, below the low-pressure header, and rises vertically at one end to the atmosphere. The live-steam line to each mixed-pressure turbine is fitted with a strainer and a combined balanced trip and throttle valve. The turbines are also provided with a vacuum breaker. In Fig. 9 is shown a side elevation of the turbines and condensing units.

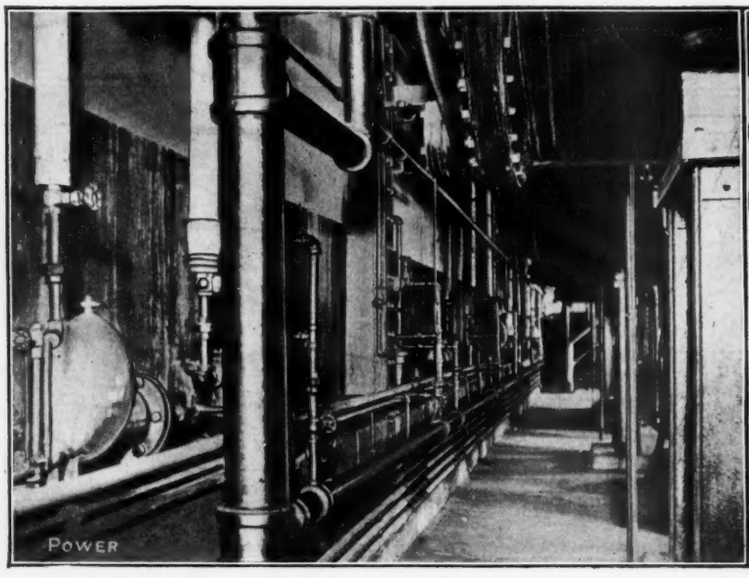


FIG. 6. ARRANGEMENT OF STEAM TRAPS AND DROP PIPING IN THE BASEMENT

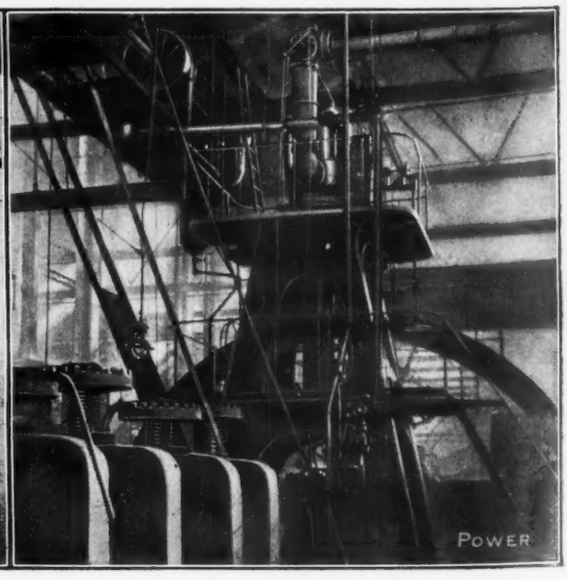


FIG. 7. THREE-WAY VALVE IN ENGINE EXHAUST PIPE

when the exhaust-steam supply falls, as it does during the noon hour, when the rolling-mill engines are shut down. At the bottom of the receiver an outlet connection is piped to the main low-pressure main from which 16-in. branches

On each exhaust-steam line, close to each turbine, is a multi-flow valve, the purpose of which is to improve the operation of the turbines when using steam from the reciprocating units. The valve prevents a vacuum in the

engine exhaust pipes, which would draw in air through leaky joints, piston rods or valve-stem packing, thus reducing the efficiency of the turbine by overloading the air pump. The valve is designed to close automatically as soon as the pressure in the exhaust line approaches the predetermined pressure, which in this installation is 16 lb. absolute.

The action of the valve backs up the flow of steam so that this pressure is maintained in the exhaust line, even though the pressure in the intermediate stage of the turbine falls to only a few pounds absolute, which will occur at partial loads. The valve disks are held to their seats by springs bearing on a movable pressure plate. By setting the plate at any point of its movement the pressure can be regulated by operating a handwheel on the outside of the valve.

This valve controls the flow of exhaust steam from the engines so long as they are in operation. When the supply fails, the governor immediately brings into operation one or more live-steam inlet valves, admitting live steam to the high-pressure nozzles, which are automatically brought into action. By using special nozzles, the high-pressure steam is expanded from boiler pressure and, in these turbines, is used on the same bucket wheel with the low-pressure steam.

At the head of each turbine, on the wall, is a gage board on which is mounted a live-steam recorder, a high- and low-pressure steam gage, and a vacuum gage. These turbines generate electrical energy for 114 alternating-current motors through the works, or a total of 2800 hp. As the motors are not loaded to capacity, the average output from the turbines, of which two are in use at one time, is about 1000 kw.

A few years ago the proposal to use exhaust steam for generating electrical energy would have been looked upon as folly. Even today, when the saving a mixed-pressure turbine will make is not understood, it is difficult to convince some engineers that the performance of this type of prime mover is not a fallacy in developing from 80 to 95 per cent. as much power as the original noncondensing engines are doing, without the expenditure of a pound of coal more or an investment for additional boilers.

The new power plant of Henry Disston & Sons, Inc., is a model of its kind and shows that the matter of design was thoroughly gone into before the installation was begun.

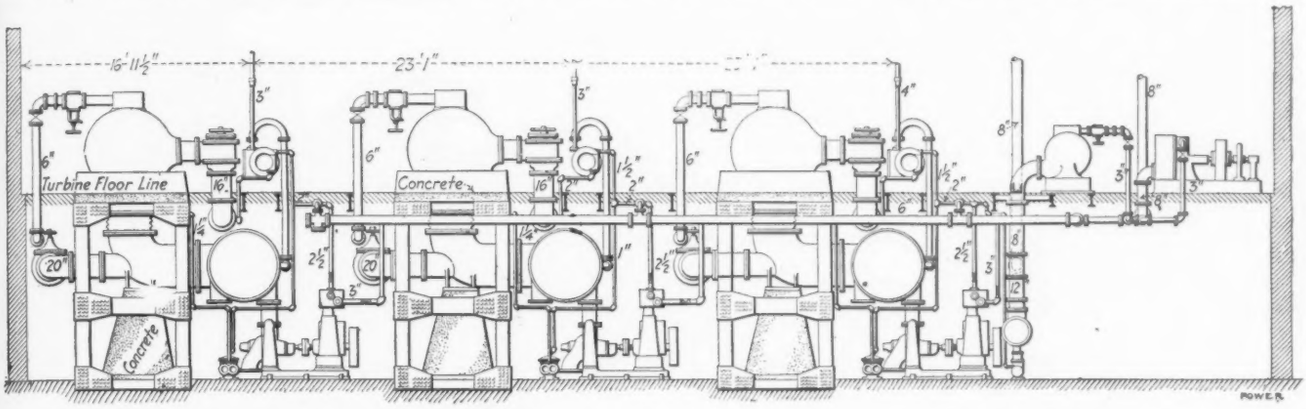


FIG. 9. END ELEVATION OF TURBINE AND CONDENSER UNITS

PRINCIPAL EQUIPMENT OF THE HENRY DISSTON & SONS MIXED-PRESSURE TURBINE PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Turbines	Curtis	1250 kw	Main units	Mixed pressure, condensing, 1800 r.p.m.	General Electric Co.
3	Generators	Alt. current	1250 kw	Main units	1800 r.p.m., 2300 v., 272 amp., 60 cycle, 2-phase	General Electric Co.
1	Turbine	Curtis	100 kw	Auxiliary unit	3600 r.p.m., 100 lb. pressure, condensing	General Electric Co.
1	Generator	Alt. current	100 kw	Auxiliary unit	3600 r.p.m., 2300 volts, 22 amp.	General Electric Co.
1	Exciter	Self contained	4 kw	Auxiliary unit	3600 r.p.m., 125 volts, 56 amp.	General Electric Co.
1	Motor	Induction	125 hp	Driving exciter	1200 r.p.m., 2200 v., 60 cycle, 2-phase	General Electric Co.
1	Turbine	Curtis	75 kw	Driving exciter	3300 r.p.m., 100 lb. steam, noncondensing	General Electric Co.
2	Generators	Direct current	75 kw	Exciter generators	1200 r.p.m., 125 v., 600 amp.	General Electric Co.
3	Air pumps	Horizontal	8x20x12"	Large condensers	100 lb. steam	Alberger Pump & Condenser Co.
3	Condensers	Surface	5000 sq.ft. cooling surface	Main turbines	28-in. vacuum	Alberger Pump & Condenser Co.
1	Condenser	Surface	300 sq.ft. cooling surface	Small turbine	28-in. vacuum	Alberger Pump & Condenser Co.
3	Pumps	Volute	12"	Circulating water	Engine driven	Alberger Pump & Condenser Co.
3	Engines	Vertical	9x7"	Circulating pumps	100 lb. steam, direct connected	Alberger Pump & Condenser Co.
3	Pumps	Duplex	6x5½x6"	Hot well water	Pumping water to boilers	Epping-Carpenter Co.
1	Fan	Propeller	42"	Basement ventilation	Motor driven	B. F. Sturtevant Co.
1	Switchboard	Slate		Electrical control		General Electric Co.
8	Traps	Ideal	Nos. 1 and 5	Condensate	Exhaust- and low-pressure lines	Tillotsen Humidifier Co.
4	Traps	Stickles		Condensate	High-pressure steam lines	Open Coil Heater & Purifier Co.
3	Valves	Trip and throttle		Turbine live steam line	Automatic	Schutte & Koerting Co.
3	Valves	Multiported	18"	Low-pressure turbine line	Automatic steam pressure control	Harrison Safety Boiler Works.
4	Valves	Vacuum breaker		Steam turbines	Automatic	Schutte & Koerting Co.

Power Site Reserve in Nevada—An order was recently issued by Secretary Lane, with the President's approval, creating a power site reserve in Boulder Cañon, on the Colorado River, 20 miles east of Las Vegas, Nev. It is expected the construction will develop 40,000 hp. at a minimum of expense. Secretary Lane announced that the classification of public lands as irrigable or nonirrigable, in conformity with the administration of the 320-acre homestead laws, was being accomplished satisfactorily. The Secretary has designated more than 900,000 acres in various Western States for entry under the terms of the act. The designations include 250,000 acres in Arizona, 5500 in California, 55,000 in Colorado, 27,000 in Idaho, nearly 200,000 in Montana, more than 8000 in North Dakota, 274,000 in Oregon, 5700 in Utah, 21,000 in Washington and 82,500 in Wyoming.

Absorption Dynamometer

A new type of absorption dynamometer has recently been placed upon the market by the Griffin Engineering Co., Ltd., of Bath, England. Its general appearance is shown in Fig. 3, while Figs. 1 and 2 illustrate special details of its construction.

The apparatus consists essentially of an inclosed conical-ended drum inside of which are adjustable brake shoes mounted on a central shaft, driven by the motor or other source of power to be tested, the friction between the shoes and the corresponding ends of the drum being regulated by an exterior handwheel in accordance with the load to be measured. The cooling is effected by introducing a small stream of water into the lower part of the drum, the water being brought in contact with the frictional surfaces by centrifugal action and discharged opposite the inlet after being swept entirely around the inner surface of the drum. The heat generated is thus removed with a minimum quantity of cooling water, which acts also as a lubricant between the frictional surfaces.

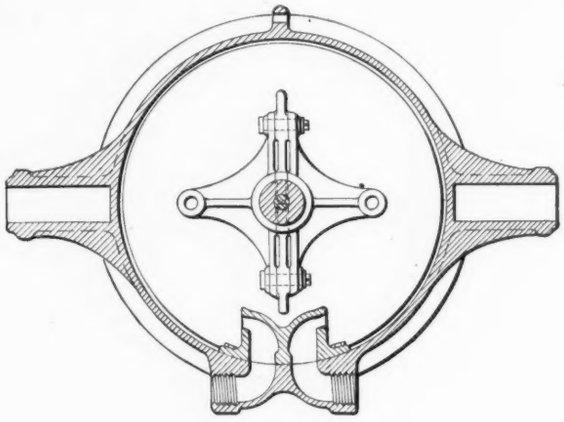


FIG. 1. VERTICAL SECTION ACROSS SHAFT

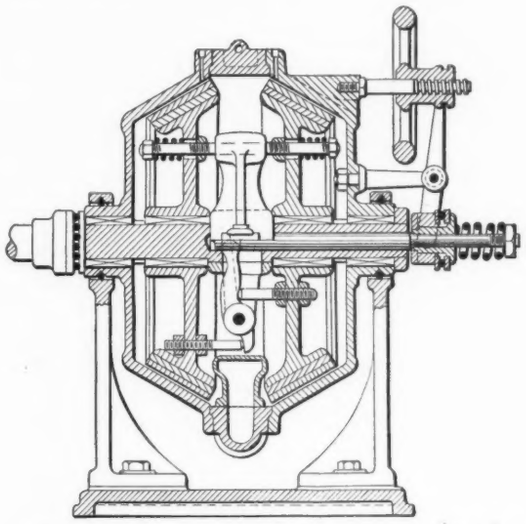


FIG. 2. VERTICAL SECTION THROUGH SHAFT

INCLOSED ABSORPTION DYNAMOMETER

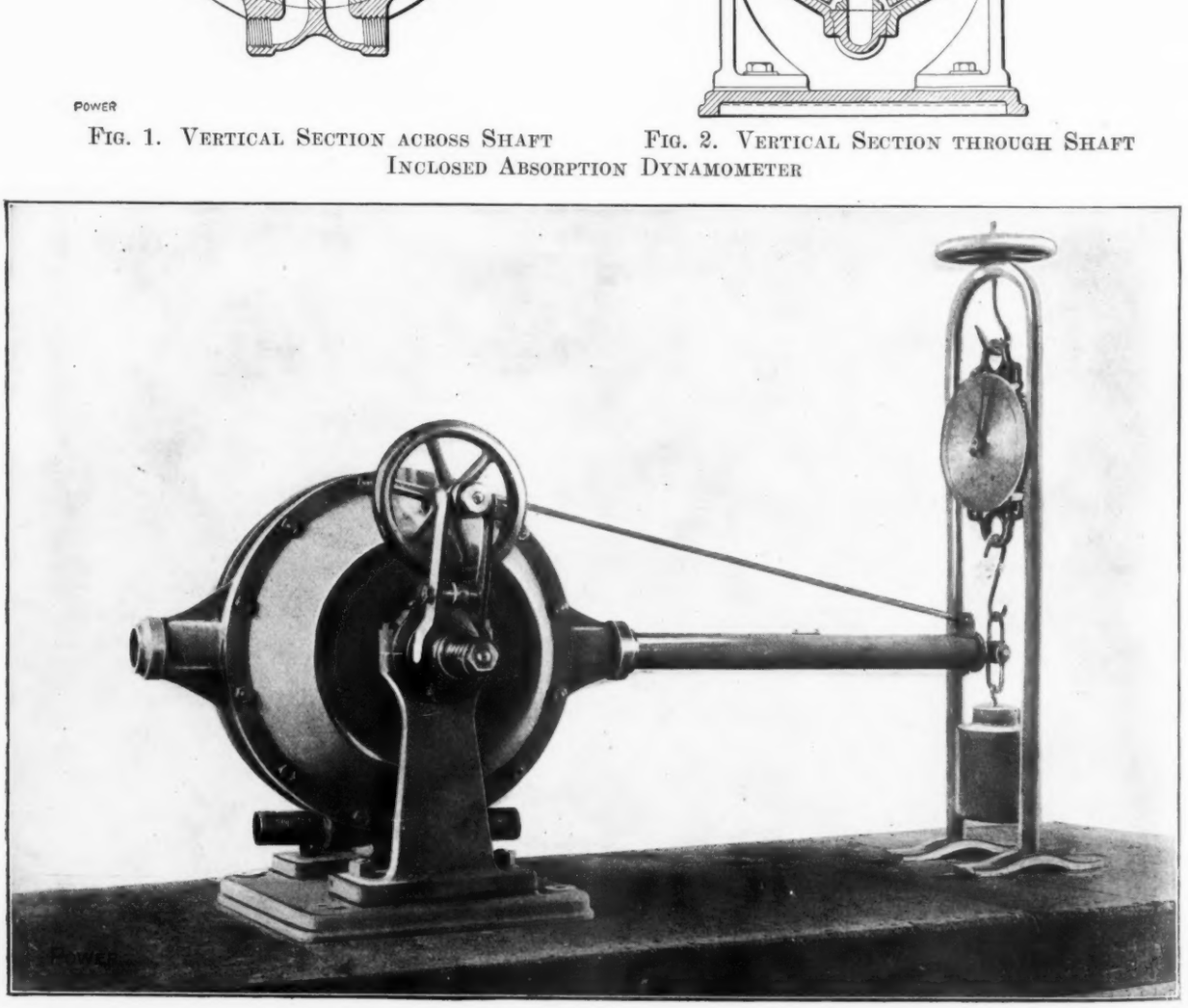


FIG. 3. INCLOSED ABSORPTION DYNAMOMETER MADE BY THE GRIFFIN ENGINEERING CO., LTD.

The drum is mounted on trunnions that oscillate on ball bearings. In this way negative resistance is nearly nil, and practically the whole of the turning effort may be considered as imparted to the brake shoes and transmitted directly to a dead weight by a lever attached to the drum. The readings are obtained as differences indicated on a spring balance as in Fig. 3, or if the effort is downward the readings may be taken directly from the spring scales without intervention of a dead weight.

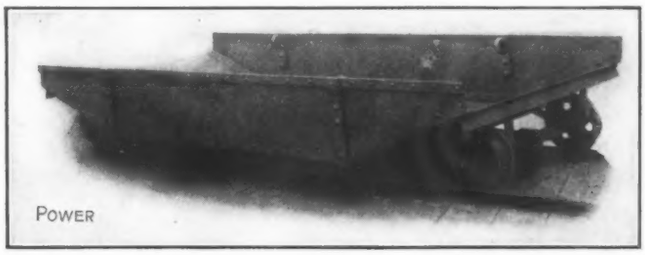
The friction of the brake shoes balances the torsional strain on the shaft and the entire apparatus may be adjusted to remain steady at all speeds and loads within its proper capacity. Shaft connections can be made direct either by means of solid or flexible couplings or through a universal joint or a flexible shaft, the latter being specially suitable for light powers and high speeds.

The apparatus is capable of being designed comparatively light in weight and there are no internal water pressures to be resisted or pumps to be operated as in the ordinary hydraulic water brake. As before stated, very little cooling water is required and this gives uniform lubrication of the frictional surfaces.

This form of friction-brake dynamometer appears to be specially suitable for long, continuous tests with either constant or variable loads. The water may be taken from any ordinary source of supply and may be conveyed away by hose, and conveniently discharged. There being but little opportunity of water leakage or the necessity for external lubrication, perfect cleanliness of the apparatus and its surroundings is secured. The apparatus is adaptable for either direction of rotation; and from its design, it appears to be an instrument meeting the requirements of motor manufacturers, electrical engineers, and for experimental work requiring an instrument capable of accurately measuring the power developed by high-speed motors in long runs.

Koppel Ash Car for the Power Plant

One way in which the efficiency of power-house operation can be increased is to provide means for handling ashes directly from ashpits without having to rake them out and then shovel them into a car or wheelbarrow.



KOPPEL ASH CAR

The Calumet & Hecla Copper Mining Co. has recently been making extensive improvements in its power plant and the car shown in the accompanying illustration was designed so that it could be run underneath the boiler grates to catch the ashes as they drop from the grate. The car was built by the Orenstein-Arthur Koppel Co., Koppel, Penn.

When the car is full, it can be pulled out and run outside the boiler house to the ash dump or lifted by a crane and dumped into a standard-gage car for removal.

The body of this car is made of $\frac{3}{16}$-in. plate, heavily reinforced to prevent warping by the heat. The wheels are cast steel with roller-bearing hubs. It is built exceptionally low, with a height of only 24 in.; gage, 36 in.; length, 12 ft.; width, 5 ft. 5½ in.; capacity, about 95 cu.ft. The use of these cars has greatly reduced the boiler-room inconvenience and labor.

Solving the Cinder Problem at Waterside--III

BY CHARLES H. BROMLEY

SYNOPSIS—This third article in the series describes more of the cinder catchers used at the Waterside station. By enlarging the flues and reducing the velocity of the gases to less than one-half the original velocity, 40 per cent., of the cinder was removed. A velocity of 1½ ft. per sec. is required to precipitate 90 per cent. of the solid particles in the gases. Twenty-four boilers are equipped with economizers for the sole purpose of catching cinder. Revolving conical screens and helical baffles are also described.

PRECIPITATION OF CINDER OFTEN IMPRACTICAL

The next step in catching cinder at Waterside was to greatly enlarge the flues. Fig. 7 shows the enlarged flues; the dotted lines indicate the original flues. The velocity of the gas was reduced to less than one-half the original velocity, and about 40 per cent. of the cinder was removed. During these tests with the enlarged flues it was found that a gas velocity of 1½ ft. per sec. must be maintained in boiler-furnace flues to precipitate approximately 90 per cent. of the solid matter. Such a low velocity is not practical in places where real-estate values are high, as in the section occupied by the Waterside stations, for flues of enormous proportions would be necessary to handle the volume of gas. Flues with numerous kinds of baffles placed normally with the gas flow were next tried, but they removed little cinder and seriously affected the draft.

ECONOMIZERS INSTALLED AS CINDER CATCHERS

Twenty-four of the boilers were next equipped with economizers, as shown in Fig. 8. These economizers were installed for the sole purpose of catching cinder, and, as the tubes were staggered as usual, it was hoped that much of the cinder would strike the tubes and be thrown into hoppers below. The installation was a failure, as little of the suspended solids was removed and the economizers so seriously interfered with the draft that they were soon discarded.

Separating Cinder from Gases by Centrifugal Force

A number of experiments were made on removing the cinder by means of centrifugal force, by imparting a whirling motion to the gases and throwing the cinder out into the pockets in the flues or stacks. To try out such apparatus an experiment station was erected.

An interesting centrifugal "filter," Fig. 9, was proposed, and experiments were made on a model, but the results did not justify an installation of this apparatus. Notice the enormity of the flue, and that the gases are caused to sweep down at high velocity over filters at *A*, which hold the cinder but allow the gases to pass. Such an apparatus might prove suitable in ordinary plants where the coal consumption is not high.

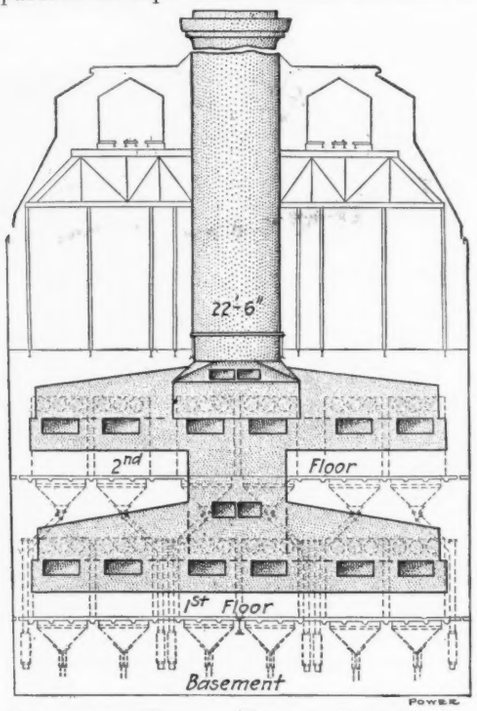


Fig. 7. Enlarged Flues; Dotted Lines Show Tops of Original Flues

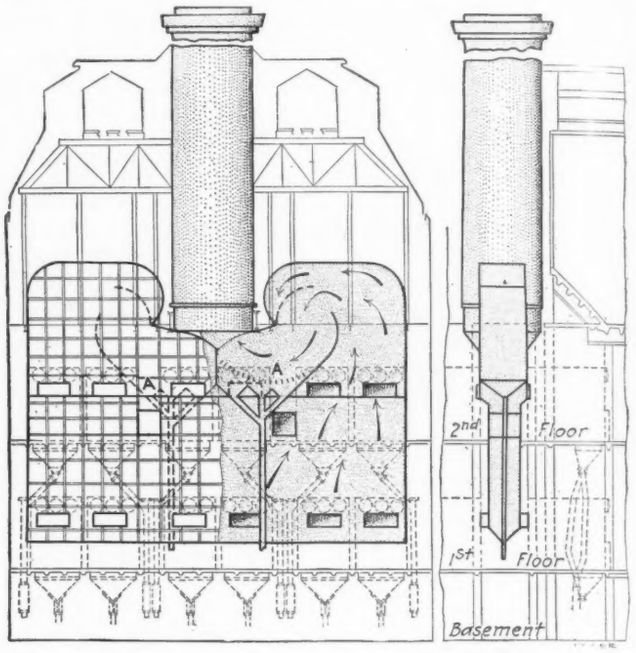


Fig. 9. Proposed Centrifugal Filter to Throw Cinder from Gases

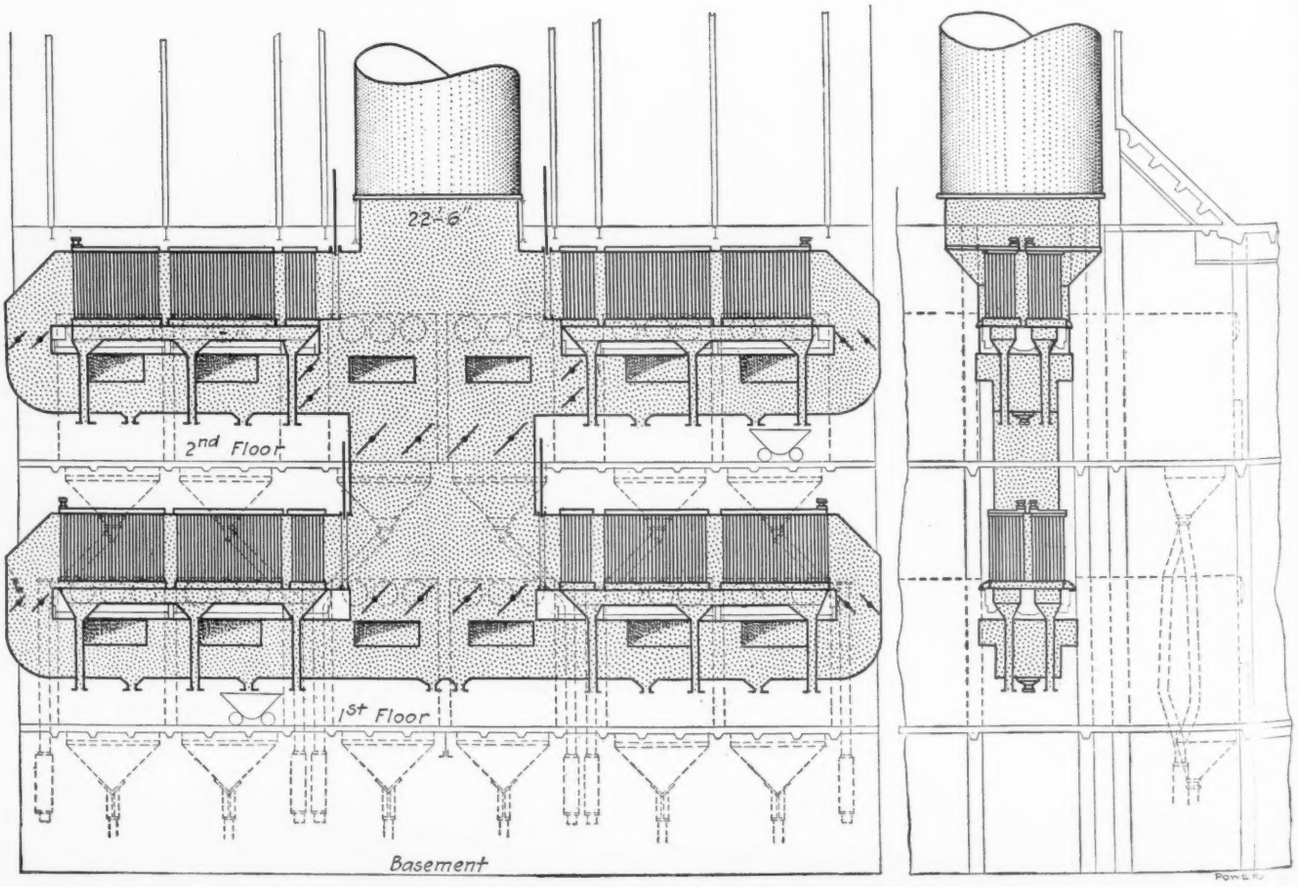


Fig. 8. Economizers in Flues to Catch Cinder; Note Damper Arrangement

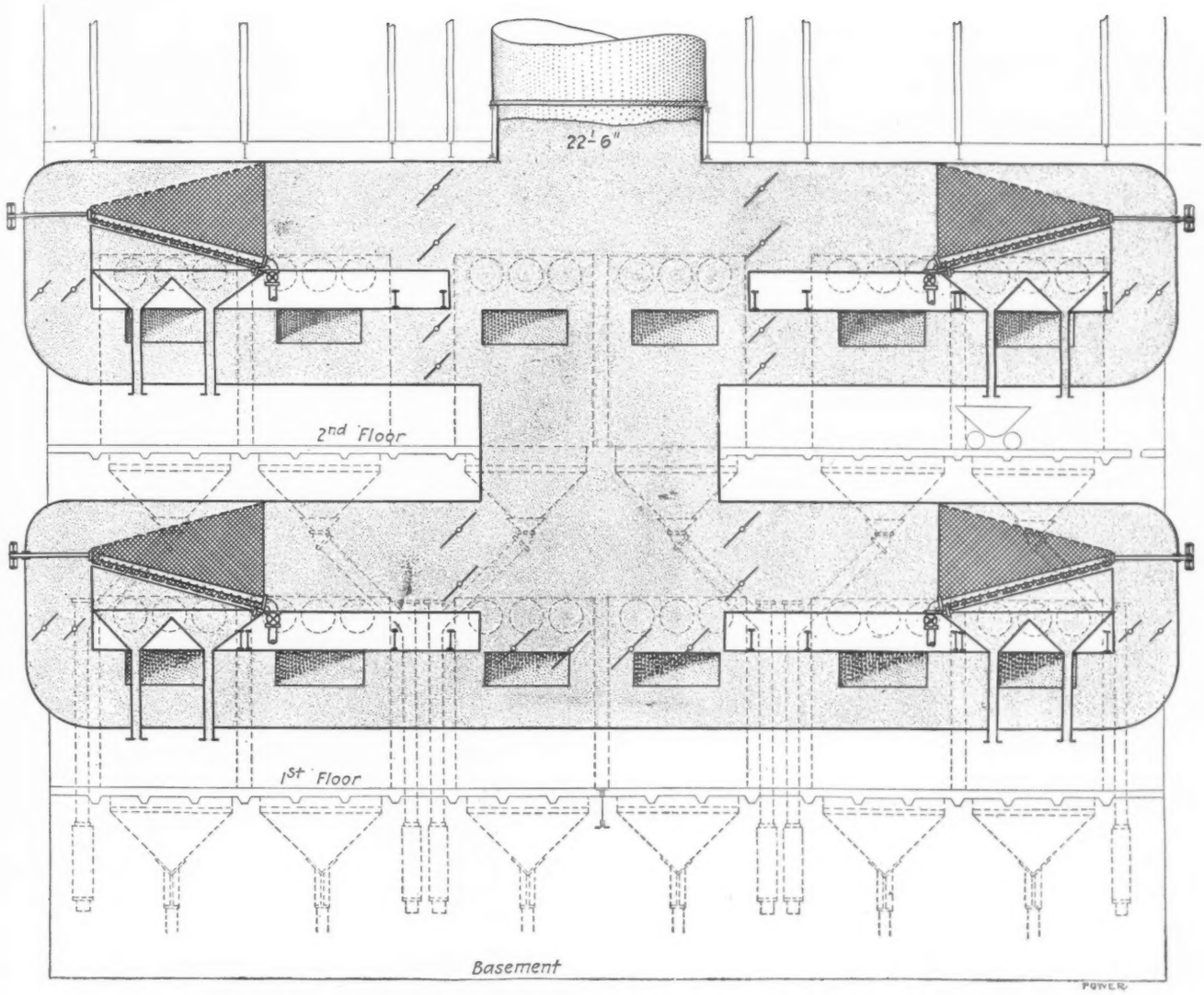


FIG. 10. REVOLVING WATER-WASHED CONICAL SCREENS; NOTE DAMPERS

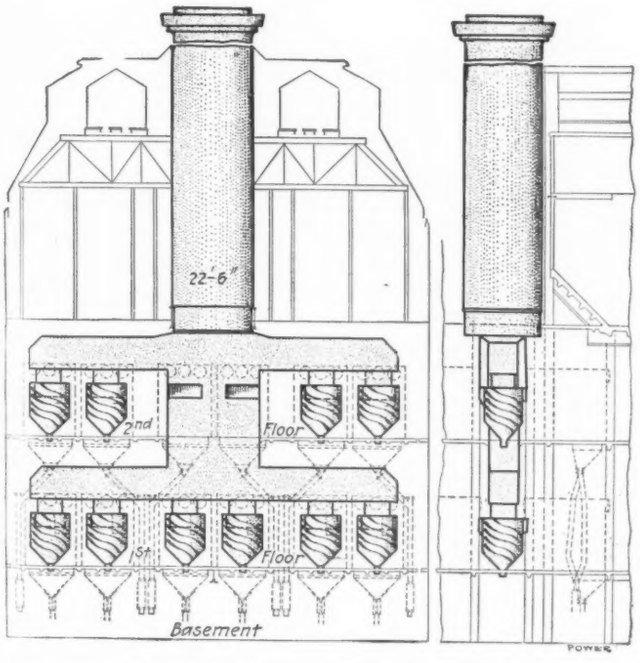


FIG. 12. SPIRAL BAFFLE FILTERS IN BOILER UPTAKES

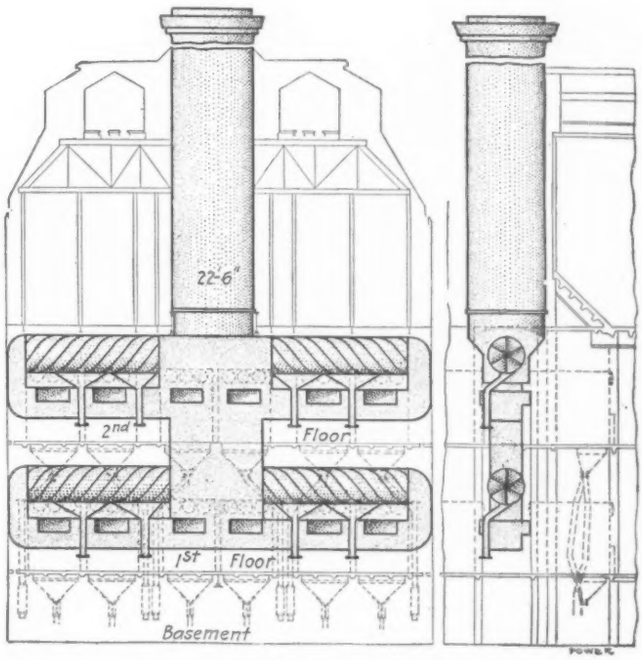


FIG. 13. HELICAL BAFFLES WITH SOOT HOPPERS IN FLUES

Revolving Conical Screens in Flues

Revolving conical screens were installed in remodeled flues, as in Fig. 10. The flues were provided with numerous dampers so that the gases could be forced through the conical screens or allowed to be bypassed unobstructed to the stack.

These screens were driven by motors placed outside the flues, each motor driving a screen through a pinion which meshed into gear teeth on the large periphery of the screen cone. Two ways of driving are shown at the left in Fig. 11.

A trough of sheet iron was built under each screen, and had waste pipes leading to the basement. A water

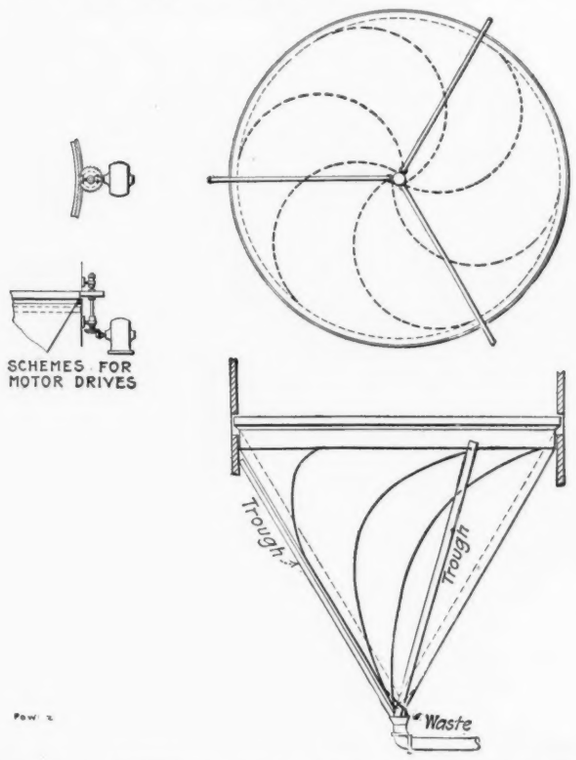


Fig. 11. Diagrams of Vanes and Motor-Drive Schemes for Revolving Conical Screens

pipe was run up in the inside of each screen, as shown, and the side of the pipe next to the screen was perforated to project numerous fine jets of water through the screen and carry the cinder into the troughs from which the waste was carried to the basement.

Some of the cones were provided on the outside with spiral vanes, Fig. 11, on which the gases impinged, water being run over the vanes and through the screen to take away the cinder. Spiral vanes of corrugated iron were also used to provide more surface for contact with the gases.

Centrifugal Filters and Helical Baffles in Flues

Two interesting methods, planned by an expert in cinder elimination, are shown in Figs. 12 and 13. The former shows centrifugal filters, consisting of spiral baffles in casings placed in the uptake of each boiler; each casing had an outlet at the bottom to take away the cinder.

The same expert designed helical baffle-plates for the flues, the latter being given the same shape and damper arrangement as when the economizers were installed. Fig. 13 shows the arrangement of the baffles, which were provided with hoppers to catch the cinder as it was thrown from the gases.

Automatically Timed Firing

Many means of firing stationary steam boilers have been instituted in boiler rooms, and the adherent of each is likely to believe that the one he uses is the best for the individual case. There are many firemen, however, who would be skeptical of any means of firing by mechanical timing, believing that such a practice would be disadvantageous both to themselves and to the efficiency of the plant.

An automatic timer has recently been perfected and designed to produce in regular succession and at predetermined intervals, a continuity of impulses for signaling purposes, as by the flashing of lights or ringing of gongs, or both, for indicating the periods at which the coaling and slicing of fires should be done.

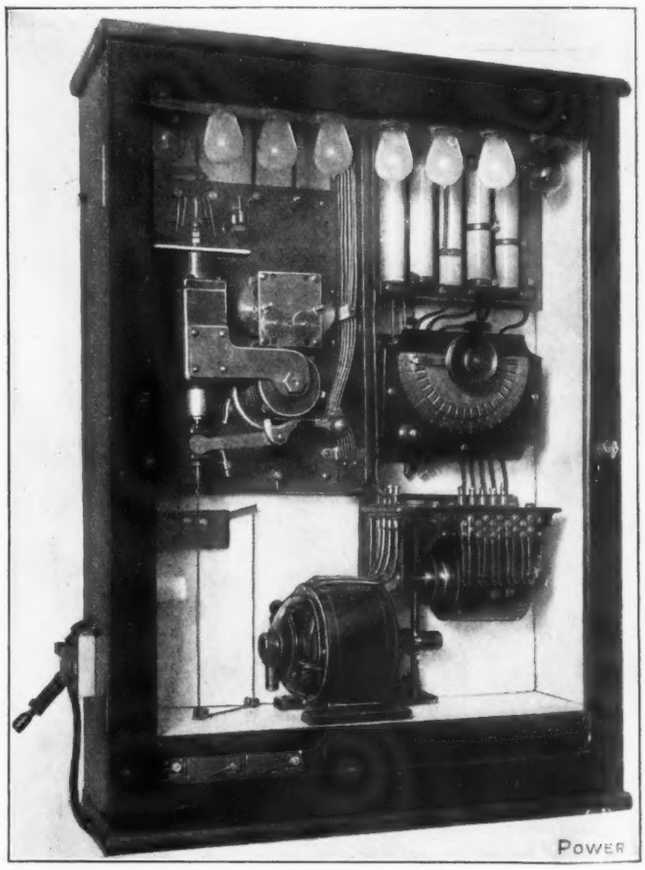


Fig. 1. Essential Parts of the Timer

Referring to Fig. 1, the apparatus consists essentially of four parts. The selecting switch is shown at the center of the right-hand side of the apparatus. It consists of contact points which connect with an internal roving bridge. There is also an external knob handle and indicator as shown.

Below the selecting switch is a frequency drum, operated by a direct-current motor, the speed between the motor and drum being reduced by a train of reduction gears.

On the left-hand side of the apparatus is a sequence drum, the torque of which is maintained by a compound

spring motor. The speed is regulated and controlled by an escapement lever operated by a solenoid that is energized by intermittent impulses from the frequency drum.

At the top of the case are indicators, consisting of pilot lamps which are illuminated simultaneously with the field indicators, which latter may consist of lamp

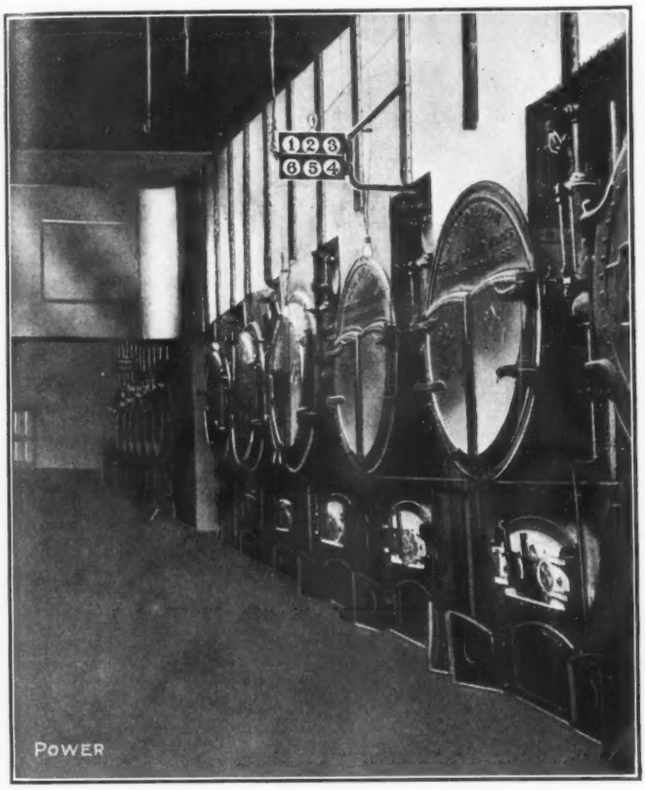


FIG. 2. BOILER-ROOM INDICATOR IN POSITION

signals, gongs, semaphores or other electrically actuated mechanical apparatus arranged singly or in groups as required.

When used as a signaling device for timing the periods of slicing fires and for firing, the engineer first determines by test the frequency with which the furnace should be fired to maintain the desired steam pressure. He then indicates the time of firing by setting the index of the selecting switch at the point corresponding with such frequency, and the apparatus will then automatically produce the proper signals in the boiler room, Fig. 2, on the field indicators which consist of lamps, etc., as before mentioned. An enlarged view is shown in Fig. 3.

The signaling is accomplished within the mechanism itself by a combination of motor control and distribution of current passing through a series of make-and-break contacts on the periphery of the frequency drum.

As an example of how the device works, suppose it has been the practice for the fireman to throw on a quantity of coal sufficient to last for, say, 20 min. The automatic timer is installed and by tests the engineer finds that 5-min. intervals for stoking is sufficient to maintain the steam pressure when firing, say, four shovels of coal per furnace door. The selecting switch of the timer is set so that the numbered indicator lights will be successively illuminated, and the gong will ring every 5 min. for firing and for slicing the fires. Beginning, say, with No. 1 boiler, the fireman fires so many shovels into No. 1 furnace when that number is illuminated and immediately slices the No. 3 furnace previously coaled. Upon the next signal he coals No. 2 furnace and slices No. 4, then coals No. 3 furnace and slices No. 1 and so on in rotation as the signals are given, alternately firing and slicing the fires at 5-min. intervals.

When additional load is to be put on the generating unit, the engineer times the firing periods to occur more frequently so that by the time the peak load is on, the furnaces are in a condition to maintain the extra volume of steam demanded.

Referring to Fig. 1, a counter will be seen at the left of the motor. This counter registers every firing and by multiplying the number registered during a day's run by the shovels per firing of coal and this by the weight of coal in each shovelful, the total day's coal consumption is determined within a few pounds. It has been found that the amount of coal fired per shovelful day by day does not vary materially. If a tally of the extra coal required for lighting or peak periods is desired a similar calculation starting and ending with the load will give the desired figures. Thus the timer checks the fuel consumption of any particular load.

With this apparatus it is possible to multiply the number of impulses which may be sent out both by the sequence unit and by the frequency unit. This is accomplished by the design of the make-and-break switches which are independent in their action and, therefore, capable of separate and distinct effort at any time. It

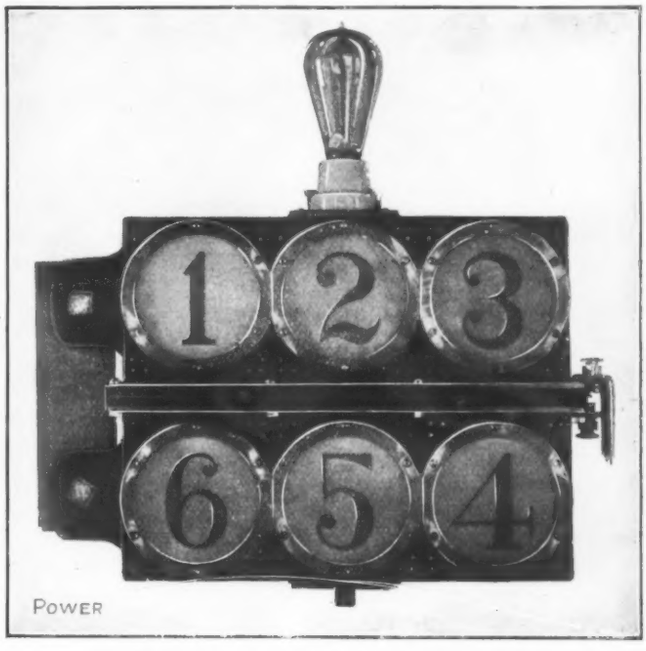


FIG. 3. BOILER-ROOM INDICATOR

is possible to transmit the electric impulse from the frequency drum without the intervention of the sequence mechanism, in which case the timing device would consist only of the first and second and possibly the fourth units already described. On the other hand, for any series of operations requiring the transmission of electric energy in periodic succession to two or more points, the third or sequence unit is necessary and the design or type of such unit is dependent upon the number of stations to be successively served.

On the dial plate of the selecting switch there is provided a series of numbered registrations at which points the index may be set to secure the different indications. These vary in periodic frequency from 45 sec. to 10 min.

The range of usefulness of this timing device is not limited to the timing of boiler stoking and elimination of smoke. It may be used for automatically flushing toilets throughout a factory and at variable periods of frequency at the will of the engineer or superintendent. It may also be used for controlling the periodic operation of ventilating apparatus in mines or buildings, for the periodic supply of injection water, for the operation of blast valves in smelting furnaces, continuous foundry work, plating and other processes and for any other operation having to be performed intermittently at regular or variable periods of frequency.

The Automatic Timer is sold by the Merchant Engineers Corporation, 30 Church St., New York City.

Concrete Pipe Conduits

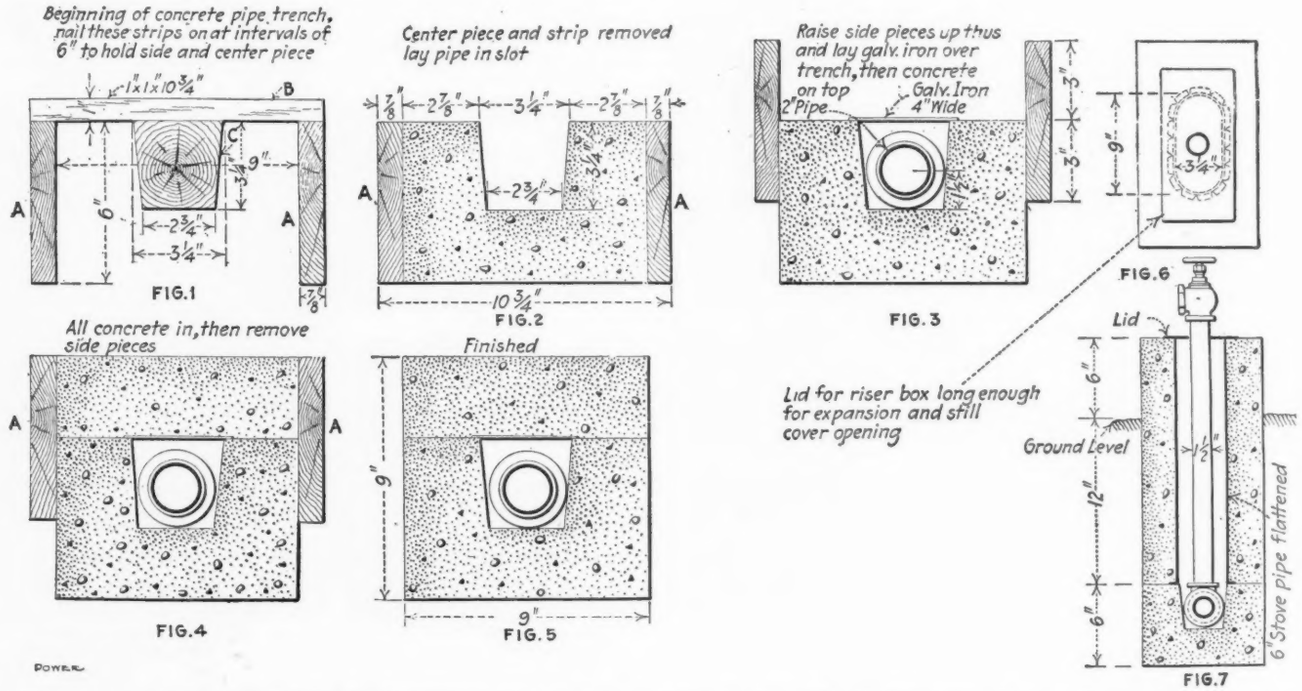
By Fred A. Down

SYNOPSIS—An economical method of constructing efficient and durable conduits of concrete for small steam lines.

The trouble experienced in installing and maintaining steam lines underground is well known, especially where cinders have been used for grading. To lay a pipe line in cinders means a continuous digging up and renewing of pipes, for the life of wrought-iron or steel pipe in cinders is short and cinders alone make a poor insulator.

Some kind of covering must be employed to save the pipe and to prevent condensation. After using several kinds of material, including tin-lined wood casing, ordinary tile, split tile, and oak, pine, cypress and other kinds of wood coverings, each has been found to have its faults. I have used concrete conduits for air and oil lines, there being little expansion or contraction, but providing for a steam line is a different proposition. With the knowledge gained in laying approximately 17,000 ft. of air lines in concrete and knowing that it was immune from disintegrating action of the elements and of the cinders, I employed a similar conduit for steam pipes. It is very simple and less expensive than others, and to those who would keep down the cost of maintenance and raise the standard of service, our manner of providing conduits for small sizes of underground steam pipes may be of interest.

Our method of providing for a 2-in. steam line would be to first dig a trench the required size and depth, and set in it two ⅞x6-in. fence boards *A*, Fig. 1, placed on edge 9 in. apart. Next, nail a piece *C*, used as a core for forming the slot in the center, to the strips *B*, 1x1x10¾ in. spaced 6 ft. apart, and tack them to the side boards. The ditch is then filled with concrete in sections, each about 12 ft. long, made of 10 parts of small stone or gravel, five parts sand and two parts cement. Mix the concrete to a slush and fill the form level with the top. Do not trowel the top, but use a broom to roughen the top surface, as the top will adhere better than if slicked with a trowel.



Figs. 1, 2, 3, 4 and 5. Cross-Sections of Conduit. Fig. 6. Lid for Riser Box. Fig. 7. Vertical Section of a Riser Box. Concrete Conduit for 2-In. Steam Line

When the concrete is set, and it will generally harden enough in 12 hr., remove the strips *B* and lift out the center core, leaving the concrete as shown in Fig. 2.

Now lay the pipe, as shown in Fig. 3, and cover the slot with a strip of thin galvanized or stove-pipe iron about 4 in. wide. Raise the side boards up 3 in., tamp dirt around the outside to hold the boards in place and fill with concrete to the top of the side boards, as in Fig. 4. When the concrete has set dry, remove the side boards, leaving the finished conduit of section like Fig. 5. If the ground is likely to hold water after a rain, it is well as an extra precaution to coat the sides and top of the conduit with hot coal tar, or with a heavy paint.

Care should be used where the risers come above the ground. For such places use a piece of 7-in. stove pipe of the right length, split and flanged over at the lower end, and flatten the sides so as to leave space for the steam line to expand. After placing the stove pipe over the riser, set a box 9x15 in. around the stove pipe, both extended about 6 in. above the ground line, and fill with concrete, as in plan, Fig. 6, and vertical section, Fig. 7. When the concrete has set, remove the outside form, pack the dirt firmly around the riser box and provide a sliding lid of sheet iron, as shown, to exclude dirt and hinder the circulation of air.

If a leak appears, remove a section of the top with a wedge, draw out the pipe, repair the leak and replace the top with new concrete. A length of 25 ft. of pipe can be drawn out and replaced with no trouble. This cannot be done with wood, log, tile, wooden box, or most other kinds of conduit on account of the inside supports. I have installed many hundred feet of this kind of conduit and can find no trace of cracks at any of the places that were uncovered to examine the concrete.

Operating Troubles When Burning Oil

By J. J. McIntosh

SYNOPSIS—Troubles from water and carbon, leakage, piping that is too small and pumps of insufficient capacity.

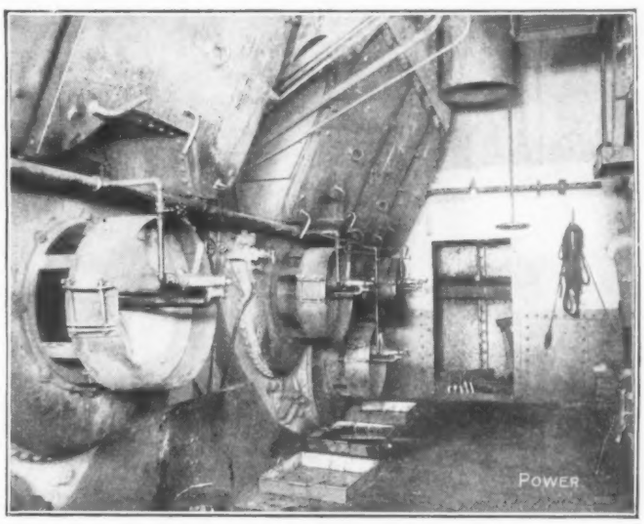
Although oil is an ideal fuel for steam-generating purposes, there are many times when the operating force experience considerable trouble in the burning of this fuel. These troubles are almost invariably due to an improper installation. It is to be regretted that the designing and installing of a plant for the burning of oil is often entrusted to persons who have had little practical experience with oil fuel, as the efficiency and reliability of the plant are primarily dependent upon the character of the installation.

Probably the most frequent trouble encountered by the operating engineer is backdraft and sputtering of the burners. This trouble is commonly called "bucking." With the fire going out at short intervals, accompanied at each ignition with an explosion of the furnace gases (causing the backdraft), with large clouds of smoke issuing from the stack and steam pressure going down, the engineer's patience is indeed sorely tried. One of the most frequent causes bringing this condition about is water.

In many cases no precaution is taken to prevent water from entering the oil well and no provision made to clear it of water. Of course, engineers allowing such a condition of affairs to exist must expect trouble. The suction pipe should never be placed closer than 4 in. to the bottom of the storage tanks and ample facilities must be provided to clear the tanks of water. The common steam siphon will be found a convenient and cheap appliance for this purpose.

Sometimes a plant is fitted with a foot valve on the suction. On account of the nature of fuel oil this appliance ought to be omitted, and its cost applied to good strainers. A plugged foot valve increases the vacuum carried on the suction line, which may cause the oil to give off its lighter fractions. This gas in issuing from the burners causes bucking.

In many oil-burning plants the suction lines are too small. This is a mistake frequently made by those who have had little practical experience with fuel oil. They assume that the same size suction will do for oil as for

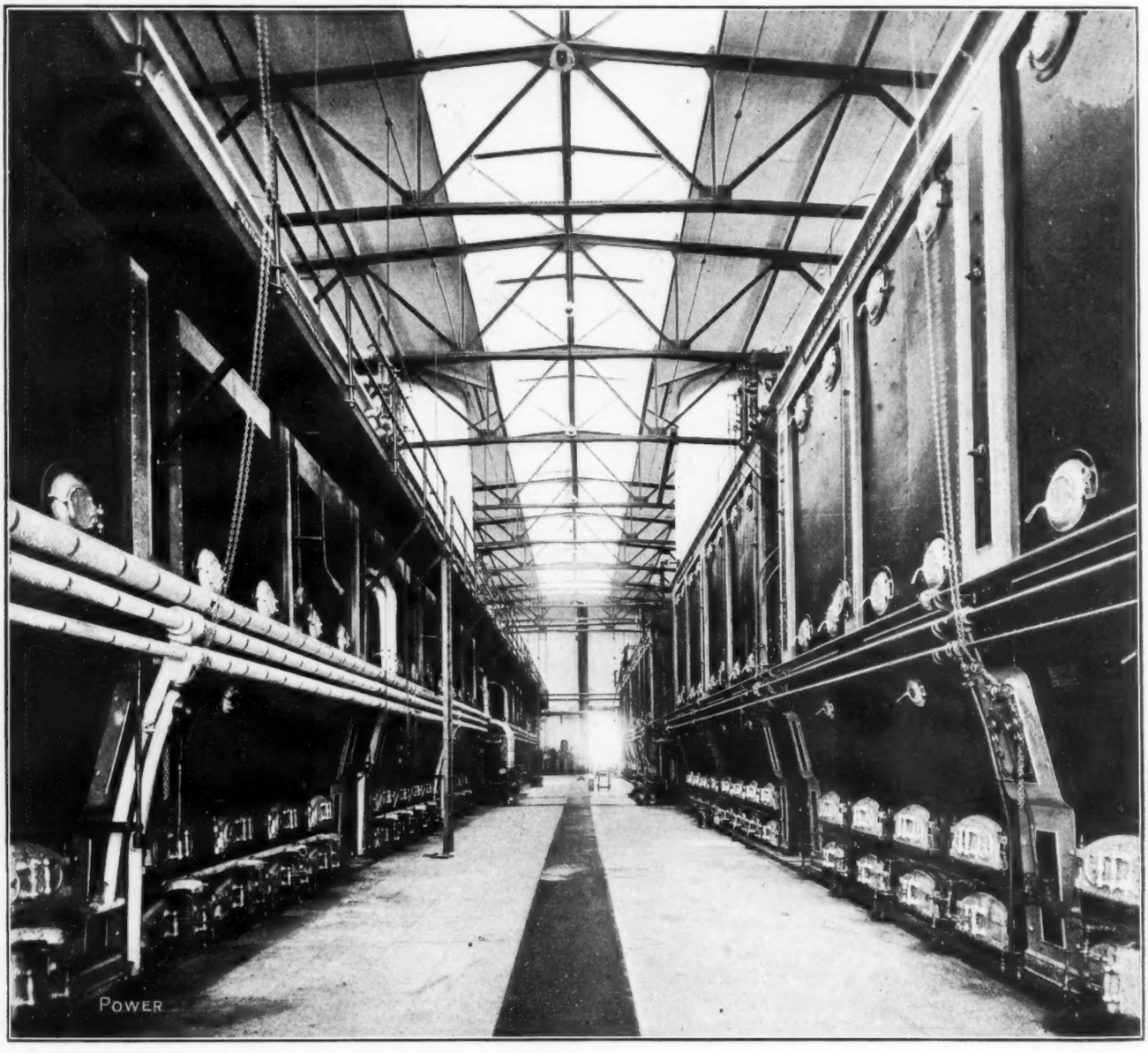


Marine Installation of Koerting Mechanical Burners

water for the same quantity pumped. On account of the viscosity of fuel oils, their flow is sluggish unless highly heated. As fuel oils give off their lighter fractions when their temperature is increased above a certain point, without a corresponding increase in pressure, it is obviously impossible to decrease their viscosity on the suction side of the pumps to such an extent that their flow will be the same as water. If trouble is to be avoided, the suction pipe must be from one to two sizes larger than that necessary for the pumping of water.

The same trouble is experienced in installations having an insufficient pump capacity. One authority on fuel oil states that the speed of pumps used to pump oil to the burner line should never exceed 20 strokes per minute.

It is obvious that if the oil becomes hot enough to give off its lighter fractions, that trouble is sure to occur. Every fuel-oil installation should have some provision on both the suction and discharge sides of the pumps where-



OIL-FIRED BOILERS AT SOUTHERN CALIFORNIA EDISON CO.'S PLANT AT LONG BEACH

by the temperature of the oil can be ascertained at a glance. The operating force must pay close attention to this phase of the work at all times.

Leaky pumps, suction lines, valves, etc., will cause bucking. Air issuing from the burners will put out the fire. Air chambers will materially reduce this trouble, but in any case all piping, valves, pumps and other appliances ought to be absolutely tight.

Pump pulsation may cause bucking of the fire. An air chamber or a gas separator will remedy this trouble by smoothing out the pulsations of the pump.

Another source of trouble in oil-burning plants is carbon. The formation of carbon in the furnace indicates incomplete combustion and may be brought about by a variety of conditions. It is generally caused by a partly plugged burner, wet steam, water in the oil, too wide or worn burner tips or by an improperly designed furnace.

The melting out of furnace firebrick can generally be traced to localized heat or blowpipe action.

In fitting up a plant for oil burning it is important to provide ample means for delivering clean hot oil to the burners and to select a burner that will maintain a clear flame in a cold furnace.

In designing a furnace practice has shown that practically all air must pass through the flame; that the flame must not be allowed to impinge directly on either boiler sheets, tubes or brickwork; that the flame produces better results when worked near hot brick and distributed over as large an area as possible to prevent localization of heat; that every precaution must be taken to guard against excess air, and that the efficiency and reliability of an oil-burning installation is primarily dependent upon the character of the installation.

Emptying Ammonia System

By Thomas G. Thurston

Pumping out the ammonia from the different parts of a modern refrigerating system should be a comparatively simple matter, but I have found from experience that a large number of men who called themselves refrigerating engineers were incapable of and totally unfamiliar with pumping out a section of the system for alterations or repairs.

Most compressors are now provided with pump-out connections so that any section of the system can be pumped

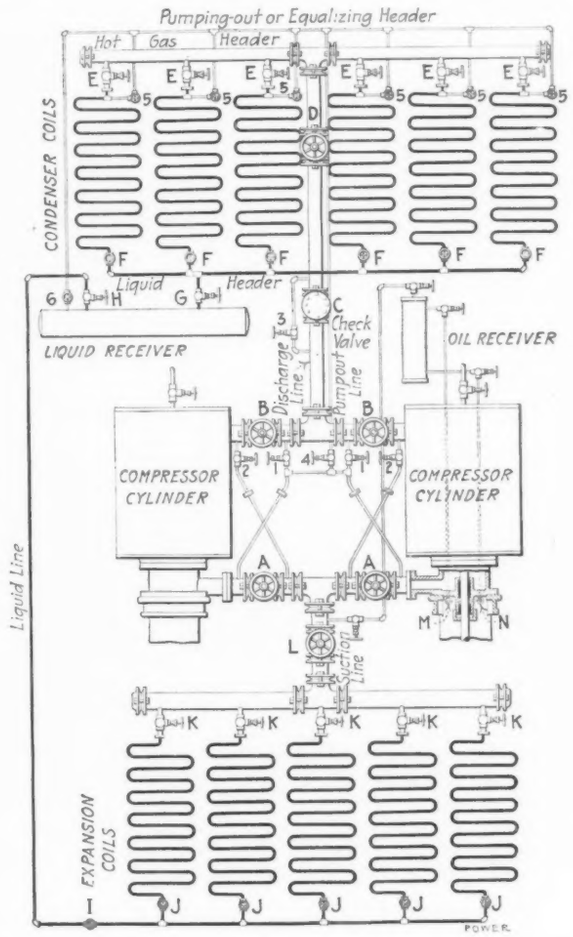


Fig. 1. An Ammonia Compression System with Pump-out Connections

out and the ammonia stored in another part of the system. Generally a compressor is provided with bypasses or cross-connections, and a separate pump-out line from the suction side of the compressor to the condenser, liquid receiver and sometimes to the liquid line. In a double-pipe or atmospheric condenser the pump-out line is connected to each individual stand, so that each stand can be pumped out separately.

The beginner and a large number of the more or less experienced men look at the bypasses as some sort of a Chinese puzzle. Nothing could be more absurd, however, as by tracing the piping it is simple enough to determine the purpose for which they were intended—to reverse the suction and discharge connections of the machine so that it will pump from the discharge line and discharge into the suction line. To run the machine this way, the main suction and discharge stop valves are closed when the machine is shut down and the bypass valves are opened instead.

Fig. 1 shows the pump-out connections for a vertical single-acting twin-cylinder compressor. Suppose that it is desired to pump out the suction line. This may be done by closing the valve *L* near the suction header on the expansion coils if there is one, or if there is not by closing all the suction valves *K* on the expansion coils. The machine is kept running as in normal operation until the suction-pressure gage indicates a slight vacuum. This operation may have to be repeated several times as a suction line is generally covered and any liquid ammonia which may be present in the line evaporates slowly. When the suction gage indicates no rise in pressure after the machine is shut down, it is safe to assume that the line is pumped out, although precautions should be taken even then, if joints are opened, against an escape of vapor.

The suction-gas header at the expansion coils is pumped out by closing the suction valves *K* on the expansion coils and proceeding as before. In case one or more of these valves leak, close all the expansion valves *J* on the coils and pump the coils down to zero or a slight vacuum before closing the suction valves *K*.

To pump out the expansion coils, close valve *I* in the liquid line at the expansion coils, if one is provided; otherwise close the expansion valves and go ahead as before. A better and safer method is to close the valve *H* in the liquid line at the receiver, pump the coils down to zero a couple of times, then close valve *I* and the expansion valves and finish the pumping with these closed. This will eliminate trouble from leaky valves. In case a single coil is to be pumped out it is better to proceed the same way for the first pumping out. Then close valve *I*, the expansion valve on the coil to be pumped out and the suction valves *K* on all the other coils. Pump the coil down, close the suction valve *K*, open the suction valves on the other coils, open the valves *I* and *H* in the liquid line and the machine is ready to resume normal operation.

The liquid header at the expansion coils is pumped out in the same way. For the first pumping, valve *H* is closed. Valve *I* at the header is then closed and the pumping finished. The expansion valves *J* should be closed immediately after the machine is shut down, to keep the gas from backing into the header from the expansion coils and the suction line. If valve *I* is not provided the liquid line must be pumped out with the header.

Suppose it is desired to repair some part of the machine or pack a stuffing-box; any good engineer who wishes to keep down his ammonia bill will pump out the machine to do this, but I have seen a number of engineers just shut the suction and discharge stop valves, open the indicator cock or purge valve and let the ammonia blow to the four winds. To pump out the machine, close the main suction and discharge stop valves *A* and *B*, when the machine is stopped, and the valve *D* in

the discharge line to the condenser. Open valves 1 and 2 on the bypasses and the bypass valve 3 on the bypass to the check valve *C* in the discharge line. By tracing the connections it will be seen that the machine will now pump from the discharge line and discharge into the suction line. Run the machine slowly and when the head pressure gage indicates a few inches of vacuum shut the machine down and just before it stops close valves 2 on the bypasses. This prevents vapor from the suction line backing up into the machine when it stops. Now open the discharge stop valves *B* slightly to let the vapor between these valves and the discharge valves in the machine escape into the discharge line. It is for this reason that a vacuum is pumped on the discharge line.

Close the stop valves *B* again and valves 1 on the bypasses, also valve 3 on the check-valve bypass; then open the purge valve and let the remaining vapor if any escape to the atmosphere.

In pumping out a machine, care should be taken to close valves *M* and *N* on each side of the oil lantern, especially if the packing is bad, as the vapor will leak back through the gas-relief line of the oil lantern and through the last half of the packing into the machine.

When ready to start, turn the machine over a few revolutions with the purge valves open to expel the air from the machine, then close the purge valves and start up in the regular manner.

Pumping out the discharge line is done in the same way except that the operation may have to be repeated a couple of times to get all of the vapor out, as there is always more or less ammonia in the oil trap, which takes time to evaporate.

To pump out the gas header on the condenser close the stop valves *E* on the individual stands and leave valve *D* open. Then proceed as before. Trouble is often occasioned by one or more of these valves leaking. In this case close the liquid valves *F* between the coils and the liquid header on the coils or stands having the leaky gas valves. Leave the leaky gas valves open and pump out the coils with the header. In doing this I have found it good practice to drain the water from the coils where a double-pipe condenser is used, as it is liable to freeze and burst the pipe or return bends unless a good circulation is kept up.

To pump out the condenser, close the valve *G* in the liquid header at the receiver and use the bypasses the same as before. Keep the water circulating rapidly or better still drain the coils in case a double-pipe or submerged condenser is used. Otherwise some of the coils are likely to be found burst after pumping out. I can remember one case where a condenser was ruined by the engineer failing to take this precaution.

An individual stand is most readily pumped out by the pump-out line and most of it can be done while the machine is in normal operation by closing the liquid valve *F* between the coil and liquid header and valve *E* between the coil and gas header, thus cutting out the coil. Valve 5 in the pump-out line is opened and valve 4 at the machine. The coil will then pump down to suction pressure with the machine in normal operation. After this the operation can be finished by closing the main suction stop valves *A* on the machine and pumping on the coil alone. A gage should be provided on the pump-out line to avoid pumping a high vacuum on the line and drawing air into the system.

A coil can also be pumped out by using the bypasses. The liquid valve *F* on the coil to be pumped out and the gas valves *E* on all the coils but this one are closed. This is more like work, however, and keeps the machine out of service longer.

I can remember one case where with no pump-out line and no bypasses a condenser coil was pumped out by closing the liquid valves *F* on all the coils but the one to be pumped out and closing the gas valve on this coil. The coil was pumped out through the expansion coils, the liquid line and liquid receiver.

The liquid receiver can be pumped out through the pump-out line or the expansion coils and the liquid line, or through both in succession, which is the best and quickest way. Close valve *G* in the liquid header between the condenser and the receiver, pump down to zero a couple of times, close valve *H* in the liquid line and stop

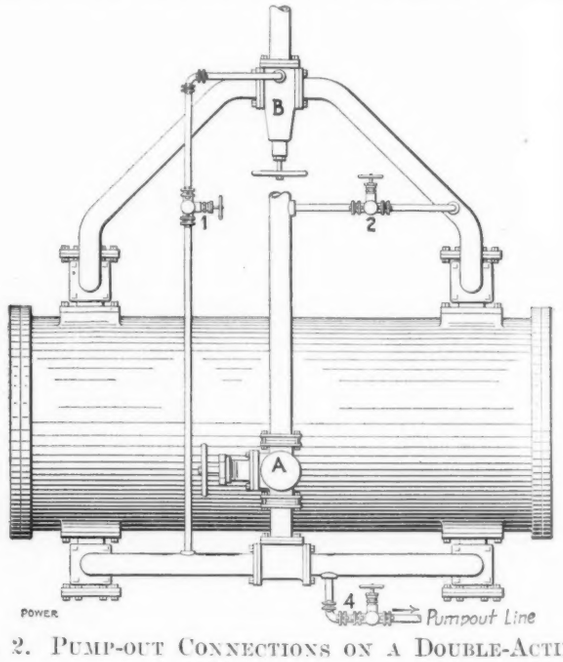


FIG. 2. PUMP-OUT CONNECTIONS ON A DOUBLE-ACTING COMPRESSOR

valves *A* at the machine and finish the pumping with the pump-out line.

Pumping out the liquid line is about the hardest problem because the line is generally covered and the liquid evaporates slowly. If the pump-out line is connected to it at the receiver end it can be pumped from both ends at once. The liquid will drain to one end or the other and pump out more readily. If the pump-out line is not connected, time and trouble will be saved by pumping out both the receiver and liquid line in the same way as just described for the receiver.

All the instructions apply where one machine is in operation. Where there are several the pump-out connections are generally connected to a common line both from the machines and the condensers, so that any machine can be used for pumping out. The suction and discharge headers are also cross-connected in a large number of cases. This makes pumping out possible in a number of cases where otherwise it would be necessary to let the ammonia blow to waste.

As an illustration, last summer a suction valve blew out on a horizontal machine. After the suction and discharge stop valves had been closed it was found that the

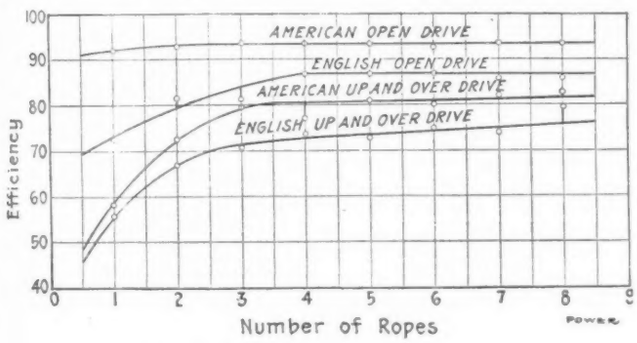
discharge valves leaked enough to make it unpleasant around the machine. We closed the stop valve in the discharge line at the condenser header and intended to let the vapor blow away when I happened to think that one of the discharge lines of the other machines was cross-connected to it. By using the cross-connection and bypasses on the other machine it was possible to pump down the line, saving the ammonia and making it more pleasant for the men to work at the machine.

In another case we broke one of the discharge valves on one of two machines working on the same system. It did not interfere with the regular operation of the machine but made it impossible to shut the valve off and a slow job to pump the machine out. We finally hit upon the idea of pumping it out with the other machine. We left the suction-stop valve open on the machine with the broken discharge valve, opened the bypass from the discharge side of the machine to the suction line and the bypass on the check valve, first closing the valve in the discharge line at the condenser, letting the vapor from the discharge line escape through the bypasses into the suction line which was pumped down to zero by the other machine.

Fig. 2 is a detail of the bypass on a double-acting compressor which requires only half the number of connections that are required by the machine shown in Fig. 1. By comparing the two illustrations, it will be seen that the valves which are marked with the numbers 1 and 2 in Fig. 2 serve the same purposes as the valves of the same numbers in Fig. 1.

Efficiency of Rope Driving

In an interesting paper read before the American Society of Mechanical Engineers, E. H. Ahara gave the results of a series of 700 tests on the transmission of power by rope drives under various conditions. The tests were all made in the open air at the plant of the Dodge Manufacturing Co., Mishawaka, Ind., on both American and English systems with open and up-and-over drives. The results include the friction of the receiving shaft and bearings, as it was thought this would more nearly approximate working conditions. The bearings were of the ring-oiling babbitted type and the ropes were all 1-in. manila of the best quality, carefully treated with a rope dressing to prevent the entrance of moisture and to keep the surface in as nearly uniform condition as possible.



Efficiency of Rope Drives

The general method of conducting the tests embraced the use of a 250-hp. Westinghouse direct-current motor, driving through an auxiliary rope drive to a jackshaft on which was mounted a 60-in. test driver; the driven shaft was fitted in bearings on a movable tower, and on the driven shaft was mounted the receiving sheave, of the same diameter as the driving sheave, and also a prony-brake wheel. The tests were made on rope drives containing from one to eight ropes, each under speeds of rope travel of 2500, 3500, 4500 and 5500 ft. per min. The center distances were varied in steps of 25 ft. from 25 to 150 ft., and at the same centers tests were made with varying loads.

On the American open drive it was found that the efficiency was greatest at the lowest speed. At a rope speed of 2500 ft. per min. the efficiency was approximately 96 per cent., and at 5500 ft. per min. about 90 per cent. The results of the efficiency tests relative to varying centers were practically uniform, and those on efficiency as to the number of ropes showed a lower efficiency on the lower number of ropes. With one rope the efficiency was about 88 per cent. and with three ropes it increased to practically 93 per cent.; from three up to eight ropes it remained constant. The lower efficiency up to three ropes was probably because the eight-grooved wheel, made for testing eight ropes, was used for all the lesser number of ropes, and this, together with the weight of the prony brake, increased the proportional friction on the smaller loads, so that it would be a larger percentage of the total load in the drive of few ropes. Limiting the losses to those in the rope alone, it was believed that the efficiency of a single rope would be as great, if not greater, than any multiple thereof. At 100, 75 and 50 per cent. loads the efficiency was practically uniform, but at one-quarter load it dropped approximately 7 per cent.

Tests to ascertain what tension in the slack side of the rope would give the highest efficiency showed that 180 lb. was best. Up to 180 lb. the efficiency increased, and from there up to 360 lb. remained constant.

Efficiency tests comparing exact and differential drives gave results considerably in favor of the former.

The up-and-over American drive, so called because of its course upward from a driver over idler wheels, then horizontally for a distance, and down over idler wheels to the driven wheel, was tested on approximately 100-ft. centers. The results of efficiency versus number of ropes, shown in the illustration, will serve as a basis of comparison where but two additional right-angle turns are introduced, requiring four additional idlers.

The results obtained in the tests of the English open drive showed a falling off in efficiency with increase in speed, the drop running from 90 per cent. at 2500 ft. per min. to 84.5 per cent. at 5500 ft. per min. The efficiency of the English drive also remained practically constant irrespective of center distances. With reference to the number of ropes, it increased, as did the American system, for the first few ropes, and then remained almost constant.

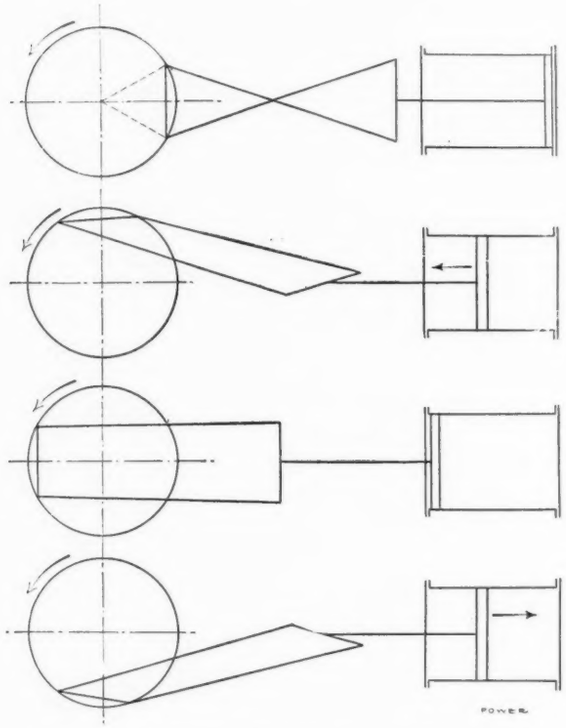
In the up-and-over English drive, tests at the four speeds previously given showed that the efficiency in-

creased rapidly with the first three ropes and then gradually up to eight ropes, although the maximum efficiency was not as high as that attained with the open drive.

The illustration gives a representative comparison of the efficiencies of the four general plans of rope driving, at a center distance of 100 ft. and a rope speed of 4500 ft. per min. These tests were made at three-quarter load, which would be 165 hp.

The Williams Connecting-Rod System

The principle of the double connecting-rod devised by T. Williams, manager of the Harvey Engineering Co., of Glasgow, referred to in the editorial on page 202, is shown in the diagrams reproduced herewith from *The Engineer*.



THE WILLIAMS DUPLEX CONNECTING-ROD

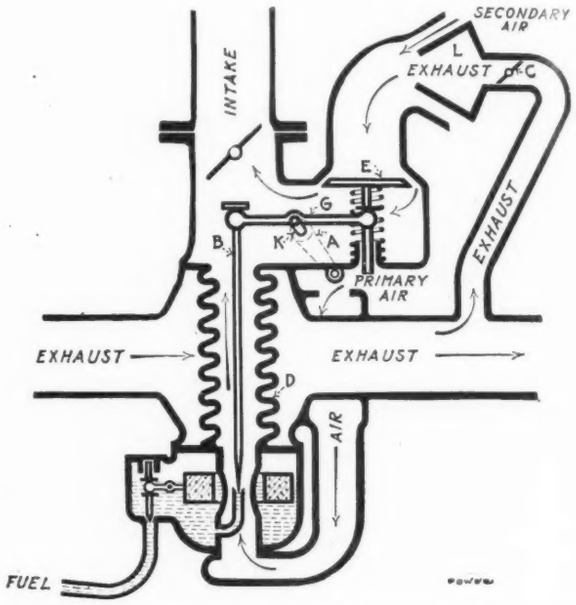
The stroke of the piston is less than the diameter of the crankpin circle, permitting, for the same stroke, an increased crank throw and the choice between a slightly shorter length of bed or a slightly longer connecting-rod. The claims advanced for its effect upon steam economy seem to us to be preposterous.

Harroun Kerosene Carburetor

The illustration represents a sectional view of the Harroun kerosene carburetor. Part of the exhaust is forced through the space around the venturi which heats this corrugated surface to a cherry red. This passage is of spiral form and as the dense atomized fuel is drawn through by the suction of the motor the heavier parts are thrown to the outside against the heated surface by the centrifugal force and the more volatile portion remains in the center.

The fuel, as it is sprayed from the nozzle and comes in contact with this hot surface, is turned into a vapor. This vapor is partially mixed with air which comes through from the bottom of the venturi and is further diluted with cold air passing through the secondary air valve.

The fuel inlet in the nozzle is automatically opened and closed by the action of the secondary air valve, and there is but one adjustment of the carburetor; this is at



SECTION THROUGH HARROUN KEROSENE CARBURETOR

the lever *A*, which raises and lowers the fulcrum of the rocker arm and in turn raises and lowers the needle *B*, as it is actuated by the air valve *E*.

A special feature of this carburetor is the taking of a small portion of the exhaust gas back into the charge through the air-valve opening. This prevents preignition and eliminates the disagreeable pound more prevalent with kerosene than with gasoline. The amount of exhaust gas used is determined by the butterfly valve *C*.

Petroleum Production in 1913—The output of petroleum in 1913 exceeded 240,000,000 bbl., according to estimates of David T. Day, of the United States Geological Survey. The production in 1912, which made the record up to that time, was 222,113,218 bbl.

The following is an estimate of the production in 1913, compared with the statistics for 1912:

State	1913	1912
California	98,000,000	86,450,767
Oklahoma	62,500,000	51,427,071
Illinois	22,000,000	28,601,308
Texas	14,000,000	11,735,057
Louisiana	12,000,000	9,263,439
West Virginia	11,000,000	12,128,962
Ohio	8,000,000	8,969,007
Pennsylvania	7,000,000	7,837,948
Wyoming	3,000,000	1,572,306
Kansas	2,000,000	1,592,796
Indiana	900,000	970,009
New York	800,000	874,128
Kentucky	500,000	484,368
Colorado	200,000	206,052
Other states	100,000	.....
Total	242,000,000	222,113,218

Pennsylvania's Anthracite Production in 1913—Final figures for 1913 show that the total shipments of anthracite coal from Pennsylvania last year were 69,069,628 tons. This is 5,459,050 more than in 1912, when the output was curtailed during the suspension of work pending the signing of a new scale of wages. The tonnage is 884,669 tons less than in 1911, which was the record year for high production.

Editorials

Transportation Problems of the Power Station

Transportation is the backbone and life of manufacturing and mercantile interests, for without it business paralysis would inevitably result

The transportation problem begins with the erection of the power station and its adjuncts, regardless of whether it is hydro-electric development or steam generation, although in subsequent operation the steam-generating station is at the mercy of transportation companies to a greater extent than is the hydro-electric plant, where the only transportation problems of serious importance which develop after the plant is once in operation, are those connected with extensions and repairs.

With the steam power plant, however, the situation is different, for there, the unceasing problem of fuel supply, and the possible interruptions to service connected therewith, is always present. The character of the service and, above all, whether it is divided between two or more companies and is competitive and wholesome are factors to consider.

It is of vital importance, in the selection of the site for a power station, to have a liberal regard for all that pertains to transportation facilities at the outset and also in subsequent operation.

Eight Dollars a Week

When is an engineer not an engineer? No, this is not a conundrum, but a plain question that needs a specific answer, judging from the indiscriminate use of the word. We answer that an engineer is not an engineer when he is a fireman, or an oiler, or an engine starter; not until he is capable of operating or of directing the operation of a steam power plant.

How foolish, then, is the following advertisement that appeared recently in a New York daily newspaper:

ENGINEER wanted, elderly man, third-class license, attend boiler only; wages, $8. .....

An engineer knows how the various appliances in a steam plant operate; what to do in case they do not work efficiently, how to handle men, and how to plan for improvements and new installations. Such men do not work for eight dollars a week.

Evidently a man is wanted to throw coal into the furnace of a boiler, and he will have nothing to do with an engine or a real engineer's job. A man with a fireman's license could fill the job as well as a "third-class engineer," if one would work for the wage offered, which is doubtful.

An elderly man is preferred, doubtless because it is assumed that a man of advanced age, holding but a third-class license, has been a failure in the engineering field and will be glad to take the job at any wages. Such a man will not be ambitious to advance and will stay contented. Probably the advertiser is tired of breaking in young men, who leave when they have learned enough to earn more money elsewhere.

On the whole, the engineers employed in stationary steam plants are intelligent and capable men. They are interested in the efficient operation of their plants, and those who are climbing are working hard to fit themselves for places of higher responsibility.

Such men should not be confused with "engineers" who care nothing for advancement, who are failures in their work, and who can be hired for a wage of eight dollars a week.

Inspecting Smoke

Because of opposition from the National Association of Stationary Engineers to the plan of having the Pittsburgh smoke inspector either a metallurgical or mechanical engineer, the city council has been forced to postpone action on an ordinance providing for the position and fixing the salary. The stationary engineers think such a provision would be unfair to men who have learned all about boilers and furnaces by experience and study, but who may not have a college degree. The engineers say they ask for no preference to be shown, but are opposed to having college graduates given preference over practical men who may be more competent.

Thus runs a news item from Pittsburgh.

We have no wish to encourage the often exaggerated antipathy of the practical man for the one with a theoretical training only. Quite the reverse, one of our ambitions is to show each the value of the other and urge their coöperation. Nevertheless, we must remark the evident justice of the stationary engineers' contention in this instance, for there is about as much reason why a smoke inspector should have a college education as that a baseball player should have had a course at a conservatory of music.

As we see the qualifications necessary in a satisfactory smoke inspector, next to good eyesight, the essential is a knowledge of the principles of combustion born of practical experience sufficient to know how to obtain smokeless burning of various fuels under various conditions. It matters not whether this knowledge was gained in or out of college.

A college education is not to be disparaged, for it can be a great advantage to anyone. The main benefit derived from it, however, is not what is learned of specific subjects, for this is soon forgotten unless the study is continued after graduation, but learning how to learn; that is, it is the training of the mind to habits of observation and deduction therefrom. Even then if the habit of thought is not related to a habit of action it is of no profit. It is the ability to apply his trained mind to useful purposes that determines the successful man. This is just as true of the man who never saw a college, but was gifted with a mind capable of training and had the determination to train it, school or no school. Such men are successes not because they had no college education, but in spite of that fact. It is the greater credit to them.

So, if we were selecting Pittsburgh's smoke inspector,

we would give him no examinations in Latin, higher mathematics r any of the "ologies." If he could pass an eye test that showed he was not seriously myopic and could explain how to burn coal completely and then prove it by actually doing it, we should accept him. And if we could get two or more such men that were equally good in these respects, we should give the preference to the man who evidently possessed the most tact so that, instead of antagonizing the offenders against the smoke laws, he would educate them to the economic advantages to themselves of complying with them.

A Magic Rod

What is the use of fussing with multiple cylinders, high pressure, superheat, etc., to increase the efficiency of an engine a small amount when by putting on a double connecting-rod you can save fifteen per cent.?

Some months since, the *London Times* described a new connection between the crosshead and the crankpin disk devised by the manager of the Harvey Engineering Co., of Glasgow. It was not surprising to see a nontechnical newspaper accept without question the statement that the use of this rod on a twenty-five-horsepower engine made a saving of seventeen per cent. in steam, and that a two hundred-horsepower cross-compound condensing engine so equipped ran on ten and a half pounds of saturated steam per indicated horsepower-hour, at one hundred and twenty pounds pressure (an efficiency of nearly eighty-three per cent.), but it was rather startling to see our dignified and conservative professional English contemporary, *The Engineer,* devote over two pages to a serious consideration of it. That paper believes "that the decreased steam consumption is, in good part, due to the circumstance that the power developed in the cylinder is transmitted more evenly to the crankshaft than is usual."

The energy developed will be the product of the pressure and the piston displacement, and no modification of the connecting mechanism can, for the abstract case at least, make any difference in the ratio of that energy to the steam required to produce it. It is conceivable that by a better distribution of the crank effort the mechanical efficiency might be improved, but inasmuch as the total internal friction of a simple engine should not exceed ten per cent., it is not easy to see how a saving of seventeen per cent. is to be accounted for along these lines. The arrangement is described on page 200.

State or Federal Control?

The *New York Sun* predicts a row between Gifford Pinchot and the President over the question whether the state or the federal government shall control the water powers, and whether either shall collect a rent or tax for their use.

The interests which are seeking to acquire and control the water powers are strong for state rights, which would seem to be a pretty good cue for those who want to save them for the people to put them under the control of the stronger and less susceptible federal power.

So far as the tax is concerned, with a proper system of rate control, it becomes one of the expenses of the business, is charged in when the rate is established and passed on to the consumer. It is only when the power is sold at what the market will bear instead of at a price which will pay a predetermined profit on the investment involved, that the public gets any net good out of a franchise tax, and it is to be hoped that the people will relinquish their hold upon these remaining sources of power only upon such terms as will insure their prompt development and the availability to the public of energy at rates which will pay a fair profit upon the money actually invested in its production. In which case, what is the difference who makes and enforces the terms so long as they are made and enforced? And which is the more likely to make and enforce them in the interest of the people, a corporation-owned state legislature or a national body whose personnel is known to and whose every act is scrutinized by an aroused people?

Another Engineer Hero

Conspicuously different from some other of the more recent marine disasters was the sinking of the "Monroe." Usually, some shameful acts of cowardice are reported, but not a single account of such has come from the "Monroe" survivors. Mingled with the feeling of horror that always comes with the hearing of such a terrible tale is one of pride and gratitude that the behavior of an American crew in the face of expected death was so exemplary throughout, from the highest officer to the humblest colored steward.

Among the outstanding displays of bravery and heroism, next to that of Wireless Operator Kuehn, who perished because he removed his own life belt to give to a woman who had none, was that of Engineer Oscar Perkins, who at the risk of his life went down and started a reserve dynamo when the main one was put out of commission and got the lights going again. Without question, this act did much to prevent a greater loss of life and the glory belongs to an engineer.

Coal Exhaustion

A reader, evidently thinking we are alarmists on the coal-exhaustion question, sends us a very reassuring clipping from a daily paper. It reads:

> **The International Geographical Congress has just issued a pamphlet giving results of a study of the subject in 64 countries. The conclusion is that there are more than seven trillion tons yet unmined, while the present consumption is about one billion tons a year. It would seem, therefore, that the world still has coal enough to last 7000 years.**

What the International *Geological* Congress monogram on "The Coal Resources of the World" really did say was:

> **The total reserves of the world, compiled from all the reports received, amount to 7,397,533 million tons. . . . The world's production of coal for the year 1910 was about 1145 million tons, so that, though much must be allowed for loss in mining and for areas that for various reasons cannot be economically mined, there still remain many hundreds of years before exhaustion of the supply may be looked for. Taking up the individual countries, however, it is found that in more than one case the end is in sight.**

Further the rate of consumption is constantly increasing, so that it is not correct to divide our reserve supply by our present annual consumption and call the quotient the number of years that coal will last. We should like to convince ourselves that the "we-should-worry?" attitude toward the exhaustion of the fuel resources is warranted, but we cannot. Just because it will not come in this generation is no excuse for indifference toward the inevitable that must be faced by posterity.

Correspondence

Running Compound Corliss Engine on Light Load

I have handled cross-compound condensing engines successfully by following these rules: Never attempt to start the engine until the condensing machinery is in operation and the vacuum gage shows the proper vacuum and that it is easily maintained; then be sure that the receiver is directly open to the atmosphere. This opening is usually a 1-in. or 1¼-in. pipe fitted with a globe valve attached to the lowest point of the receiver and is used as a bypass around the steam trap, when there is not sufficient pressure to cause the trap to operate, thus giving a positive drain to the receiver.

Then crack the throttle and use the starting bar to operate the valve-gear until the receiver pressure runs up to 20 or 25 lb. and the bypass blows freely. Everything else being ready, hook in the reach rod and admit the steam, leaving the bypass open until the engine comes up to speed and takes the load. Next go around and close the bypass and see that the receiver trap operates. Always maintain a pressure above the atmosphere in the receiver sufficient to drive all water out through the trap provided for that purpose. If the load falls off for any reason and the engine must be kept running, lower the steam pressure to get a late cutoff in the high-pressure cylinder sufficient to keep up the receiver pressure.

JOHN J. RAMSEY.

Wellington, Kan.

All compound engine receivers should be provided with two traps, a steam trap to operate with pressure above the atmosphere, as during normal operating conditions, and a vacuum trap when the receiver contains a vacuum.

A vacuum trap may be placed below the receiver so that the water will flow to it by gravity. When the water reaches a certain inlet in the trap, communication to the vacuum is closed and the trap is vented to the atmosphere, the water discharging into the air. This trap should also be connected to the exhaust line if there are any pockets that may collect water.

The engineer can readily connect a vacuum trap and a pressure trap to the receiver and have a valve stem extend to the floor line to enable him to control the trap according to operating conditions.

One of the engines in the writer's plant operates compound condensing under a varying load and at times has little more than friction load. When this condition occurs, we drop the boiler pressure until the cutoff on the high-pressure cylinder will give a suitable receiver pressure. This will allow the pressure trap to drain the receiver. This trap should be cleaned frequently because the oil from the high-pressure side will tend to clog it and prevent satisfactory operation.

If the engine is to run for long with a light load, it may be good engineering to take down the low-pressure side and carry the load with the high-pressure side if the piping is arranged to bypass the low-pressure cylinder; if not, it may pay to so pipe it.

The receiver relief valve should be given more than usual attention and should have a wire so connected that it can be raised from its seat each day.

P. E. MERRIAM.

Methuen, Mass.

Hammering Check Valves

What experience have readers of POWER had in remedying hammering check valves on heating systems where the hot water is returned direct to the boilers by means of an automatic pump and tank?

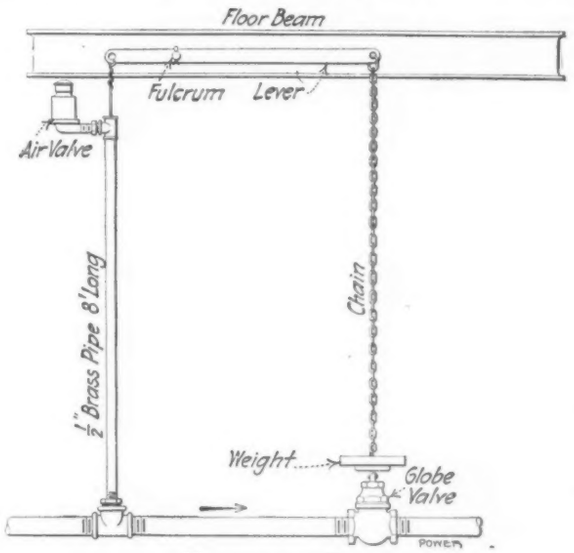
The writer's attention has been called to two cases lately in which trouble has been encountered from this action, although the piping was almost identical with that in a number of other systems which had given no trouble.

A. E. WALDEN.

Baltimore, Md.

A Simple Steam Trap

A steam trap being necessary on the outlet of a large heating coil, I decided to make one as shown in the sketch. I placed a tee in the line with a ½-in. brass riser 8 ft. long. A foot beyond that I placed a globe valve with threads filed off the stem; the pressure was under the disk. Overhead on a floor beam is a lever with one end attached to the top of the brass pipe and the other to a



HOMEMADE TRAP

chain connected to the globe valve. The fulcrum is placed so as to make the leverage three to one. On the valve is a weight to hold the disk down and yet allow it to rise in case of excessive pressure in the coil when it will allow the valve to open like a safety valve.

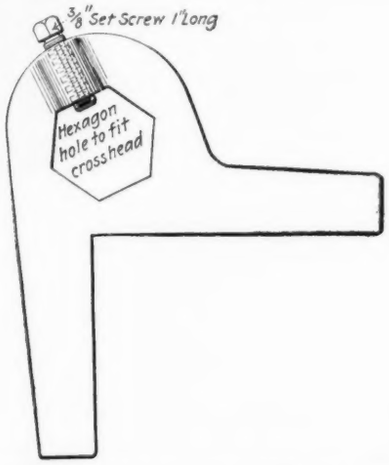
When discharging, steam reaches the brass riser, the expansion allows the globe valve to close. When water seals the riser, the valve is opened, allowing it to be discharged. This proportion of parts gives a total valve movement of about 3/8 in. The air valve on top of the riser makes the changes more rapid and the whole affair, while simple and somewhat crude, works perfectly.

H. K. Wilson.

New Bedford, Mass.

Dog for Pump Piston Rod

The illustration shows a device for use on a Prescott piston-pattern, boiler-feed pump. The idea is to prevent the piston rod and the crosshead from being turned by the valve-actuating levers. As this type of crosshead has a



hexagonal end the device is easily applied. This improvement also helps to hold the piston rod when tightening jam-nuts, etc.

W. E. Rough.

Chisholm, Minn.

Power-Plant Conditions in the South

I have read with becoming mortification of spirit the editorial bearing the above title in which you chant the obsequies of the isolated plant in the South. He died at the hands of the hydro-electric plant in the struggle for industrial supremacy. Was it murder or justifiable homicide?

Some months ago you published the rates at which power from the Hale's Bar development near Chattanooga is sold. These are supposed to be among the lowest of the hydro-electric rates, yet they make the cost of a horsepower some $20 for a 3600-hr. year. It would not take a phenomenal steam plant to beat that figure, especially if there were any use for exhaust steam, as for slashing.

The standing charges against a plant are usually assumed at about 12 per cent. A good steam turbine-driven plant can be put down for $50 per hp., entailing a standing charge of $6 per hp. per annum. The Hale's Bar development cost over $150 per hp. of maximum capacity, and at the same rate is subject to a standing charge of $18 per hp. The difference would pay the coal bill of a good steam-driven plant.

In addition, many hydro-electric plants have to maintain, as your editorial says, steam plants for stand-by or reserve service, so they have to carry the standing charges which the steam plant ordinarily has in addition to their own. Furthermore, the power delivered and collected for is considerably less than that generated, on account of line losses.

W. V. A. Powelson, a consulting engineer of New York, in an argument* opposing the charge to private parties of a rental by the government for the use of water powers, and in favor of grants in perpetuity, says that "many water powers have little or no commercial earning capacity in competition with coal," and that the number of water powers which are capable of producing power considerably cheaper than by coal is not very great.

If the hydro-electric developments of the South displace the isolated steam plants generally it will be because the steam plants are not as good as they should be, or those who are responsible for the change have not a full understanding of the facts and conditions.

Ralph E. Somers.

New York City.

Purchasing Coal on B.t.u. Basis

The government has definite specifications regarding the purchase of steaming coal in which the ash and moisture content as well as the heat value bear a definite relation to the price per ton. When bids are called for, each bidder's price is reduced to a common basis for comparison. Through three successive steps, taking into account ash, moisture percentage and B.t.u. value, the cost for 1,000,000 B.t.u. is determined. Although certain limits are established for sulphur content and volatile combustible matter, they are not taken into account in correcting the bidder's price.

The accompanying table shows the cost of 1,000,000 B.t.u. figured on the government basis, also the performance of the coal under actual operating conditions, for nine different samples. The coal was tested in a plant of 1000 boiler horsepower, the boilers being of the water-tube type, with chain-grate stokers and a draft of 0.30 in. maintained over the fire by a 77-in. fan. According to the government method of calculation, sample No. 1 is the cheapest coal, but tests demonstrated that it was not suitable for the work at hand, and it was not the cheapest when the cost per kilowatt-hour was considered. The table is self-explanatory. The contractor who submitted sample No. 6 was awarded the contract. Samples Nos. 2 and 3, the only coals showing a lower cost per kilowatt-hour than No. 6, together with satisfactory furnace conditions, were rejected because the contractor had a reputation for slow delivery.

COST AND PRACTICAL TESTS OF COALS

No. of Sample	Kind Bit.	Cost of 1,000,000 B.t.u.	Practical Test Chain-Grate Stokers, Induced Draft: Cost per Kw.-hr.	Behavior of Coal	Remarks
1	N&S	$0.041	$0.021	Clinkered badly	Too large
2	P&S	0.043	0.0119	Good	
3	P&S	0.043	0.0126	Good	Dusty
4	N&S	0.046	0.0178	Clinkered	Excessive slate
5	N&S	0.047	0.0127	Clinkered	Excessive slate
6	P&S	0.051	0.0128	Good	
7	P&S	0.061	0.0125	Fair	
8	N&S	0.0645	0.018	Fair	Gummy
9	N&S	0.065	0.0153	Clinkered	Too large

N&S = Nut and slack; P&S = Pea and slack.

It would seem valuable, as a check on practical tests,

*Senate Document 243, 63d Congress, first session.

that some relation be established between the price paid for coal and the heat value, ash content and moisture, but the attached table shows that it would be inadvisable to contract for a coal supply without testing out thoroughly, under actual operating conditions, different coals on the market most accessible to the plant in question. Again, as in the case at hand, there may be factors to be taken into account besides low cost of operation and clinkers. If previous experience has shown that certain contractors or mines are unreliable or unfitted to handle the business, they should be stricken from the list of bidders.

There comes to my mind a plant which during one year used a certain coal selected on a B.t.u. basis and fired under hand-stoked boilers. The ash was of such quantity and quality that as much labor was required to handle the ashes and clean fires as to handle the coal, to say nothing of damaged furnace walls.

P. J. Bryant.

Jeffersonville, Ind.

Getting Rope over Top of Stack

Several times within his experience the writer has had to place a rope over the top of a self-supporting stack. Sometimes it has been desirable to paint the outside of the smokestack and the rope running through the pulley at the top has broken or fallen. Frequently in isolated plants inconvenience is occasioned by this trivial accident.

There are several simple methods for getting a wire or a rope over the top of the stack. One method is to use an ordinary skyrocket with a cord attached, on the inside of the stack. By shooting the rocket up the stack the stick will fall on the outside, and pull a fine cord with it, which will in turn pull a larger one up until a rope of any size desired can be drawn up. It is an easy matter then for anyone to scale a stack with a rope that is extended up the inside, and down to the ground on the outside.

Sometimes in isolated places a skyrocket is hard to obtain at some seasons of the year, and then a much simpler method can be employed. It consists of erecting a cross-bow inside the stack and then shooting an arrow, or any other projectile, up the inside and let it fall on the outside, pulling a fine cord with it. In some of the larger cities, where steeple-jacks can be secured, this work can be delegated to them, but it will save much expense if the engineer in charge knows this little trick of getting the rope over the top of the stack.

Letson Balliet.

Tonopah, Nev.

Slip of Reciprocating Pumps

F. F. Nickel's communication regarding the slippage of reciprocating pumps, in the Jan. 6 issue, contains some excellent material for discussion.

First, the article states that "the rate of leakage is practically constant . . . If the slip at full capacity is 5 per cent., then at half capacity it will be 10 per cent." In my article on this subject, printed in the issue of Apr. 8, 1913, the curves showing the slippage of pumps do not bear out this statement. It is true that the slip increases when the speed of the pump decreases, but not in the simple ratio stated. I said that the rated capacity of the pump tested was reached when the piston speed was about 140 ft. per min. Using this as a basis, the following is a comparison of the results actually obtained with those which Mr. Nickel would expect to find:

Piston Speed	Tested Slip	Computed Slip
	150-lb. Discharge Pressure	
140	16	16
70	24	32
35	48	64
	10-lb. Discharge Pressure	
140	5	5
70	7	10
35	20	20
17½	45	40

This tends to prove that there are more things than simply the piston speed which govern the slippage of a pump.

Second, Mr. Nickel brings up the matter of testing small pumps by closing the discharge valve and admitting steam until the normal water pressure is obtained. The speed of the pump is then noted, and if it does not exceed a certain prescribed number of strokes, 1 per cent., the pump is considered to be in good shape as far as slip is concerned. The fault I find with this method is that it takes into account practically only the slippage past the plunger, largely neglecting the leakage past the valves. This procedure also does not reproduce working conditions, as the water is practically at rest and therefore does not offer the resistance nor possess the inertia which water in motion does.

The question of pump slippage is a broad and important one, and I think many of us would be interested in hearing its further discussion.

Mervin K. Baer.

Chicago, Ill.

Operation of the Delray Boilers

There appeared in the Dec. 30 issue an abstract of a paper presented before the American Society of Mechanical Engineers, by J. W. Parker, on "Further Operation of Large Boilers of the Detroit Edison Co." This paper is interesting, especially as it involves certain theories of hand-control in boiler operation, which appear at variance with established practice. Under the subject of regulation, with reference to CO_2 results, the following statement is made:

"As to furnace conditions, the firemen must judge by the CO_2 recorder, by the amount of air pressure necessary for any given boiler load, and also by the color of the gases as they pass over the first baffle and enter the top of the superheater pass."

There is no question of being able to judge the combustion by the CO_2 results, but to judge the boiler load by the air pressure is hardly comprehensible; for the resistance of the fuel bed governs the static pressure in the ashpit to a large extent. With the fire burning thin, the ashpit pressure is reduced, and *vice versa*. Therefore, the ashpit pressure rather indicates the thickness of the fuel bed, instead of the rate of combustion, providing the fans are running at constant speed.

With further reference to CO_2 results Mr. Parker says:

"It is not desirable to substitute automatic air and stoker control if a better CO_2 chart cannot be shown thereby. The danger is that the fireman will rely on the automatic device rather than study the conditions and control his fire intelligently. With the present hand control, excellent furnace conditions are being obtained and held. Observation of the furnace gases, as they en-

ter the superheater pass from the top of the combustion chamber, shows that the combustion of volatile gases is complete and that the operation is consequently smokeless. At the same time, the CO_2 charts give good results, 15 per cent. of CO_2 being common and the average being 13.5 to 14 per cent."

My experience cannot be reconciled with this statement, inasmuch as both the boiler and furnace efficiency have not been taken into consideration. High CO_2 does not necessarily mean a large output per pound of coal. To illustrate this point, consider the operation of five boilers in a plant, and imagine a moment when the steam pressure is dropping, say, 2 lb. If all the firemen get after their fires, before they can recover the steam pressure, it will have dropped more, and the five fires will then have to be driven to regain the pressure, and a high CO_2 will be had. Almost invariably, the steam meter will show the boilers to have been run in excess of their most efficient steaming rate with a consequent drop in efficiency. Furthermore, the drop in steam pressure undoubtedly has been due to one fire or boiler trailing behind the others, which has thrown a momentary overload on the remaining boilers. As a consequence, there must be a continued loss on all boilers. On the other hand, when the fires are brought up to their proper condition, if the load should drop off slightly, the pressure will rise, and the firemen, nine times out of ten, will immediately start hand manipulation to check the combustion and the furnace efficiency falls off, due to the formation of CO.

The nearer the combustion can be kept constant with slight changes to keep the desired steam pressure, the better will be the results. Of course, the boiler needs some constant rate of evaporation, or nearly so, for the attainment of maximum efficiency. Therefore, the ideal condition must be at a point which represents a constant rate of combustion and of evaporation.

With automatic control of the air supply and outgoing gases, one is able to fix the best condition under which the boiler is to operate, and maintain it uniformly for all rates of steaming. There follows, therefore, a regulation with respect to the particular conditions within each boiler, such as the thickness of fuel bed and compensation for blow-holes and thin spots in the fire. A predetermined pressure is maintained in the furnace chamber for all rates of combustion and is accomplished by varying the ashpit pressure to meet the different resistances of fuel beds. Therefore, there is a constant quantity of air going through the fuel bed which adjusts itself to the requirements of steam. There follows, also, an even distribution of the load on the boilers, because equal quantities of coal are burned in each furnace—i.e., the regulation is such that each boiler is made to do its pro rata share of the total output of the plant.

My observation has been that, with automatic control, the firemen are made more efficient by giving them more time to watch operating conditions, and their minds are relieved from the numerous and burdensome conditions of hand control.

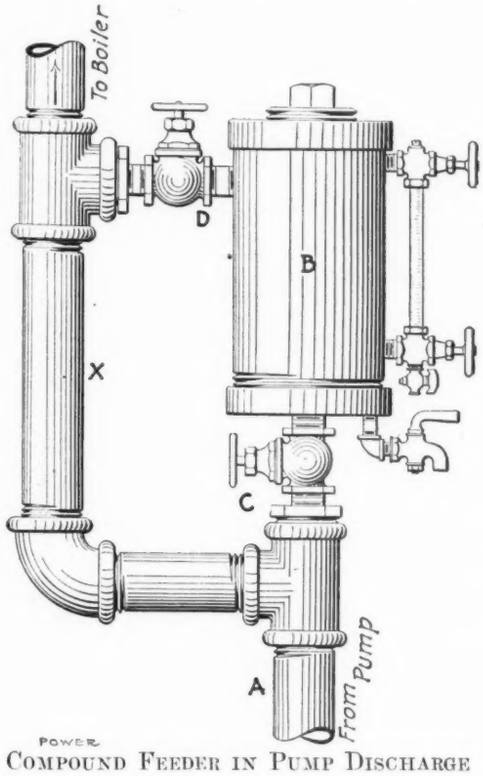
R. E. Fox, Jr.

New York City.

[Mr. Parker was not discussing the subject in general, but merely stated the practice which had been found best adapted to the conditions at the Delray station.—Editor.]

High-Pressure Compound Feeder

The illustration shows a boiler compound feeder that should prove good in operation on the discharge pipe of the feed pump. The discharge pipe *A* from the feed pump is connected to a strong cylinder *B* by pipes *C* and *D*. The top of the cylinder is provided with a plug which can be removed to allow the compound to be placed in the



Compound Feeder in Pump Discharge

cylinder. When the pump is in operation, the valve *D* is to be opened more or less, according to the amount of compound it is desired to feed. By placing a valve at *X* a positive feed of compound to the boiler could be had by closing that valve and opening valve *F* and running the pump slowly. Clear water will show in the glass when the compound is gone.

James E. Noble.

Toronto, Can.

Power-Plant Piping

The piping systems of steam plants in the United States and Canada are usually of markedly different design than those found in European countries. Although the manufacture of pipe and fittings here has been brought to a high standard, the use of certain fittings seems to have been neglected, even when the cost would not add materially to those usually employed. Some designers of steam plants apparently forget the advantage of giving steam free flow through a steam line and that right-angle turns are to be avoided.

I call to mind a steam plant in Budapest in which the steam pipe line was made with easy curves at every turn. There were six engines and the steam supply came to the center of the header feeding the engines. Where the pipes came through the boiler-house wall, care had been taken to avoid openings around them. There were no connecting doors from the engine room to the boiler

house and the boilers were stoked at the end farthest from the engine room. This construction precluded the possibility of dust, ashes and dirt working into the engine room.

The piping was of copper. On entering the engine room the main pipe branched right and left in the shape of a Y to supply the engines; these branches were made with easy curves. The outlet to the first and second engine on each branch, instead of coming out at right angles from the main supply pipe, was made by brazing in the pipe at an angle of about 60 deg. At this pipe the main supply pipe was reduced in size by a long cone and beyond the second outlet the pipe was again reduced and led to the third engine with a long-radius curve. At the end of the supply main another pipe was brazed on from the under side and, passing through and under the floor to the boiler room, discharged into a hotwell. This method was repeated on the second group of engines to the left.

Extreme care had been taken in insulating the steam pipes, the one running from the boilers to the engine room being thickly insulated at the larger end, but gradually decreased as the pipe size was reduced. The pipes at the extreme ends of the steam mains leading to the hotwell were fitted with a stop valve close to where the last engine pipe branched off. These two pipes were to drain the water from the steam main before starting up. Straightway valves were placed in the main supply pipe where it branched right and left, after entering the engine room, for cutting out either branch if one of the two groups of engines were idle, to prevent loss by radiation and condensation.

I do not recall the exact mechanical construction of the throttle valves, but the idea was that before a throttle could be opened it was necessary to turn back a lever which, when the valve was closed, folded over the handwheel of the throttle with a cap. In turning this cap out of the way a drain valve, piped above the valve seat, was opened, which drained out any water that might have collected; this water was returned to the hotwell in the boiler room.

This piping layout and other arrangements are not usually seen in America. The boiler room is generally just outside the engine room with sliding doors between, and comparatively little attention is given to making them dustproof. The piping in America would undoubtedly be of steel or wrought iron; they are cheaper and answer as well as copper, but after entering the engine room the main supply is frequently found to branch from a tee or elbow and the outlets to the engines are made in the same way. This is objectionable. Why are not more Y-connections used where the main steam pipe enters the engine room, and easy bends and Y's employed instead of tees and elbows? Long-radius bends are employed extensively in the later installation between the boilers and headers, and between the headers and engines, a decided improvement upon former practice.

In the Budapest plant I was struck with the method of arranging the intake to the suction of the air compressors. In America, air compressors usually take air from the engine room, but in the plant referred to, air ducts passed through the roof of the engine room about 12 ft. and, instead of being guyed by unsightly wires, the 12 wooden air intakes, supported horizontal pieces over which vines were growing, giving a neat and artistic effect.

W. D. Forbes.

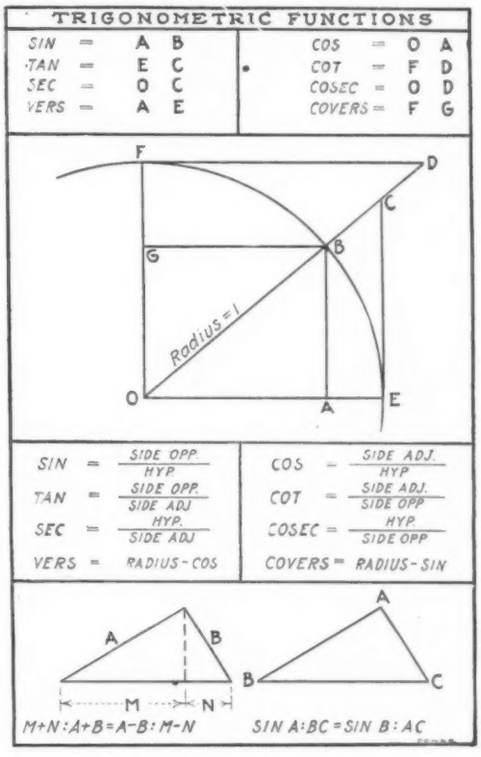
New London, Conn.

[It is true that y-connections in steam lines are infrequently used in this country, but it is the prevailing practice to use long- and short-radius fends, where possible, instead of elbows and tee connections. Furthermore, steam piping is eliminated from the engine room as much as is possible.—Ed.]

Trigonometry Data Sheet

Supplementing the lessons on trigonometry in the Study Course, the accompanying data sheet should be of service for quick reference.

It was got up by the writer several years ago; the original is a tracing which is kept in a ring-binder; blueprints being made from it as required. These blueprints



Trigonometry Data Sheet

are pasted on the inside of the covers of handbooks, such as "Kent," and the handbooks published by the manufacturers of structural steel. These handbooks are usually kept within reach, so the solution of a problem in trigonometry would be a simple matter for one who does not have the formulas indelibly impressed upon his memory.

It will be noticed that in the equations for the functions expressed as ratios, instead of using the letters *AB, OA, OB,* etc., to represent lines, they are designated as "side opposite," "side adjacent," "hypotenuse," this being more concrete and better adapted to the memory.

Underneath is found the method of solving triangles other than right-angled triangles.

C. O. Sandstrom.

Kansas City, Mo.

Misstatements Regarding Diesel Engines

Technical Paper 37, issued by the Bureau of Mines, and entitled, "Heavy Oil as a Fuel for Internal Combustion Engines," contains some questionable information on oil and a two-page description of the Diesel engine, by O. P. Hood, chief mechanical engineer, in which there are some glaring misstatements; some of these are as follows:

1. "The heat is thereby generated by a more nearly constant temperature and does not reach the high temperature or pressure of the explosion engine."

The oil engine is equipped in many cases with a relief valve which is set for 800 lb. The explosion type rarely has a pressure of more than 300 lb.

2. "Another peculiar feature of the manner in which this engine uses heat is the compression of the air for the combustion to such a degree that the heat developed thereby approximates the temperature obtained by the subsequent burning of the fuel."

The compression temperature is 1000 deg. F. and the combustion temperature around 2500 to 3000 deg.

3. "It (the temperature of compression) also causes the spontaneous ignition of the charge of the fuel, although that is not the chief reason for the high compression."

The reason for the high compression of the Diesel is to produce ignition of the charge.

4. Relative to the ignition system—"so that the engine in this subject is much simpler than the explosion engine."

It is only necessary to compare the fuel valves of a Diesel engine, with their at present unsolved troubles, and a spark plug and timer for an engine of the explosion type.

5. "In general appearance these engines are like the explosion engines, although not built so heavily."

The fact of the Diesel engines having such high pressures means that they must be heavily built.

6. Referring to fuel injection the statement is made that it is injected "at such a rate as will maintain an approximately constant temperature while burning."

As a matter of fact the Diesel engine has a constantly rising temperature during injection.

It is a waste of money to have anything of the sort published and besides it may do harm by giving false impressions.

JOHN F. WENTWORTH.

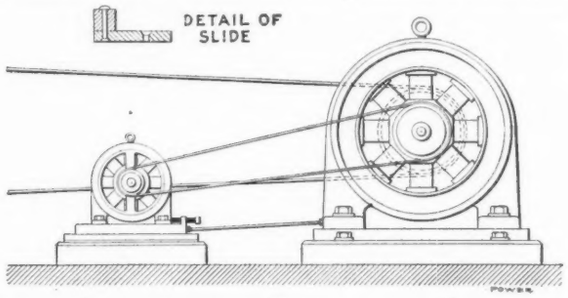
Quincy, Mass.

Belted Exciters

Probably the most vulnerable point in a belted alternator and exciter unit is the pulley end bearing of the exciter. Much inconvenience is experienced with unequal shrinkage and expansion of the main drive and exciter belts. When the main belt is tightened with the unit in use it is necessary first to slack the exciter belt, attended by possible slippage, or to throw undue strain upon the exciter bearing while the main belt is tightened and before the exciter can be moved a corresponding amount. A simple method for overcoming this difficulty is suggested as its more universal use seems warranted. The idea has been tried and found effective and convenient.

Instead of fixing the exciter base firmly to its foundation, it can be mounted upon strap-iron slides with sides projecting upward along the sides of the exciter base. A cross-section of such a slide is shown in the upper left-hand corner of the illustration. This slide permits the whole exciter to be moved upon the foundation, yet kept in alignment. A rod is now connected from the exciter base to the alternator itself; this can be fastened in any convenient manner. The length of this rod should be adjusted for the belt so that the stretch will be taken up by the adjusting screw of the exciter unit. If the exciter belt is new it is placed upon the pulleys and the exciter slid upon its base until it is at the extremity toward the alternator. The exciter base is then moved to tighten the small belt, the exciter aligned, the rails placed and the length of the connecting-rod determined. The rails and exciter foundation should be long enough to provide for the full travel of the alternator upon its base.

A modification of this method provides a rod directly



BELTED EXCITER WITH ROD BETWEEN IT AND THE GENERATOR

from the alternator to the exciter, allowing the exciter base to be bolted down, the exciter sliding upon it as the main belt is adjusted. A turnbuckle must then be placed in the rod connecting the machines to provide for adjustment of the exciter belt.

Chicago, Ill. GORDON FOX.

Testing Ammonia Piping

In the Jan. 6 issue, Gilbert Crawford, Jr., describes a method of testing direct-expansion coils in a freezing tank. While it evidently was a success in his particular case, I would not recommend it as good practice. It is not a sufficient test, and should only be used in an emergency, such as confronted Mr. Crawford.

To properly test the coils in a freezing tank, an air pressure of from 175 to 200 lb. per sq.in. should be applied, using either the ammonia compressor as an air compressor or a separate air pump. After the pressure has been applied, brush each joint with soapy water and if a leak exists, the air escaping around the threads or between the flanges will form a soap bubble which can be readily seen. After every joint has been gone over in this manner, fill the tank with water and again apply the air pressure, watching the surface of the water for air bubbles. Air pressure should be left on the coils over night and the gage read the following morning to see how much the pressure has dropped.

As a final test, the air should be blown out, which incidentally will clear the coils of scale, and a vacuum test applied for two or three hours, carefully watching the gage to see if air leaks in and reduces the reading. Sometimes the vacuum test will reveal small leaks that pressure does not indicate.

Jacksonville, Fla. C. T. BAKER.

Inquiries of General Interest

Speed of Rotor without Induced Current—Would the rotor of a three-phase squirrel-cage induction motor come up to speed if the copper bars of the rotor were removed?

W. B. F.

No, for there would be no induced current set up in the rotor.

Draft for Haulage at Different Speeds—What would be the relative drawbar pull hauling 4800-lb. loads up a 10 per cent. grade at the rate of 600 ft. per min. as compared with 800 ft. per min.?

J. H. S.

Neglecting air resistance, after the speeds become constant, the drawbar pull would be practically the same.

Testing Pump Valves—How are the suction and the discharge valves of a pump tested for leakage?

T. P. G.

By putting full water pressure on the suction and the delivery valve decks while the pump is idle and examining for leakage of the suction valves from the pump cylinder through the suction valves and for any leakage of the discharge valves back into the pump cylinder.

Temperature of Feed Water from Closed Heater—To what temperature can boiler feed water be heated in a closed heater by steam supplied at 1-lb. gage pressure?

G. C.

The temperature of steam at 1-lb. gage pressure is 215.4 deg. F., but with continuous boiler feeding the average temperature of water supplied to heaters, and with the usual proportions of clean heating surfaces, the water is generally heated to about 205 deg. F., depending on the temperature of the supply, the proportion and the cleanliness of the heating surfaces and the heat lost by radiation from the shell of the heater.

Capacity of Brick Chimney—What would be the boiler-horsepower capacity of a brick chimney 110 ft. high and having a least diameter of 48 in.?

J. G.

For ordinary conditions, the number of boiler horsepower for which a chimney is appropriate may be found by the formula

$$\text{hp.} = 3\tfrac{1}{3}\,(A - 0.6\sqrt{A}) \times \sqrt{H}$$

In which A = the cross-sectional area of the smallest part of the flue in square feet and H equals the height of the chimney in feet, according to which a chimney of the dimensions quoted would be suitable for 365 boiler-horsepower.

Kilovolt-Ampere—What is the definition of "kilovolt-ampere" and why is it used on nameplates of alternating-current apparatus instead of kilowatts?

T. H. Y.

One kilovolt-ampere is the product of one volt and one ampere times 1000, or the amperes in a circuit times the volts divided by 1000 gives the kilovolt-ampere capacity of that circuit. This also applies to kilowatts in direct-current practice, but in alternating-current work, the kilowatts are equal to the volts times the amperes times the power factor divided by 1000. A machine might carry 100 amp. and 220 volts at 80 per cent. power factor, which would be equivalent to 22 kilovolt-amperes, though delivering only 17.6 kw. Manufacturers rate their alternating-current apparatus in kilovolt-amperes to signify how much load the machine will carry under all conditions.

Reversing Direction of Engine Rotation—How can the direction of rotation of a D-slide-valve engine be reversed without removing the valve chest cover in resetting the valve?

E. T.

Approximately the same setting of the valve for reversed rotation is to be obtained by giving the eccentric the same angle of advance for the new direction of rotation. This can best be done by indicating the engine and setting the eccentric to a position on the shaft which will give indicator diagrams which are correct for the new direction of rotation; or the same angle of advance of the eccentric for opposite direction of rotation may be found by marking a point on the side of the shaft which is intersected by a radial line drawn on the side of the eccentric opposite that point of the eccentric furthest from the center of the shaft. The angle between this line and the radial direction of the crank will be the total angle the eccentric is in advance of the crank. Then place the crank on either dead center, loosen the eccentric from the shaft and turn it around the shaft in the first direction of rotation of the engine until the radial line is in line with the eccentric rod.

The distance the eccentric has thus been turned will be one-half of the total distance it is to be turned on the shaft and set for reversing the direction of rotation with the former angle of advance of the eccentric.

Size of Boiler—How is the manufacturers' horsepower rating computed for a flush-ended return-tubular boiler 66-in. diameter by 16 ft. long with ninety-six, 3-in. diameter flues?

J. D. A.

The manufacturers' horsepower ratings of sizes of externally fired boilers are based on an allowance of 10 sq.ft. of heating surface per horsepower.

With ordinary brick setting the heating surfaces of a flush-ended return-tubular boiler of the dimensions given would consist of:

(A) The area of one-half of the shell, i.e.,

$$\tfrac{1}{2} \text{ of } \frac{66 \times 3.1416}{12} \times 16 = 138.23 \text{ sq.ft.}$$

(B) The internal area of the 3-in. tubes, i.e.,

$$\frac{8.74 \text{ in. circumference}}{12} \times 16 \times 96 = 1118.72 \text{ sq.ft.}$$

and

(C) The heating surface of the heads, approximately equivalent to the area of a circle 66 in. in diameter minus twice the external cross-sectional area of the tubes, i.e., the area of 66 in. or 5½-ft. diameter being 23.758 sq.ft. and the external cross-sectional area of a 3-in. tube being 0.0491 sq.ft., the net heating surface of the heads would be approximately,

$$23.758 \text{ sq.ft.} - 2\ (0.0491 \times 96) = 14.33.$$

Adding A, B and C the total is

$$138.23 + 1118.72 + 14.33 = 1271.3 \text{ sq.ft.}$$

the manufacturers' horsepower size of the boiler would be

$$\frac{1271.3 \text{ sq.ft.}}{10} = 127.13 \text{ horsepower.}$$

Efficiency with and without Economizer—When using an economizer a boiler plant has an efficiency of 64 per cent. The water entering the economizer contains 78 B.t.u. per lb. above 32 deg. F., and upon entering the boiler it contains 176 B.t.u. per pound above 32 deg. F. The boiler evaporation is 12,000 lb. of water per hr., containing per lb. 1120 B.t.u. above 32 deg. F. The heat of combustion of the coal is 14,000 B.t.u. per lb. of coal. How many pounds of coal are burned per hour and, with the same efficiency of the boiler and using the same coal, what would be the efficiency of the plant without use of the economizer?

J. P. C.

While using the economizer the heat per hour received by the water would be

$$(1120 - 78) \times 12{,}000 = 12{,}504{,}000 \text{ B.t.u.}$$

and the heat realized would be 0.64 of 14,000, or 8960 B.t.u. per pound of coal, therefore the coal used would be

$$\frac{12{,}504{,}000}{8960} = 1395.5 \text{ lb. of coal per hr.}$$

Without using the economizer there would be a loss of 176 — 78, or 98 B.t.u. per pound of water fed to the boiler and, with the same efficiency of combustion, each pound of water evaporated would require burning

$$1 + \frac{98}{1120 - 78} = 1.094 \text{ times as much coal.}$$

Hence only $\frac{1}{1.094}$ as much heat of the coal would be realized and the efficiency of the plant would be reduced to

$$\frac{1}{1.094} \text{ of } 64 \text{ per cent., i.e., } 58\tfrac{1}{2} \text{ per cent.}$$

Engineers' Study Course

The Slide Rule--I

Were one to take two rulers, such as are shown in Fig. 1, and place them with edges touching with the left end of one on, say, the "3" of the second, it is clear that under the "2" of the first would come the "5" of the second. That is, a reading on the second would give the sum of the digits indicated. And so, any addition could be performed by such rulers.

It is only a step to a multiplying set of rulers. Since 0 times anything is 0, omit a zero point on the scales, and begin them at "1," and taking any arbitrary space to the right from "1," make a mark and call it "2." Slide one rule along the other until the "1" of one scale comes opposite the "2" of the second and under the "2" of the first make a mark on the second, calling it "4." Now slide the "1" on the upper scale to "4" and under "2" mark "8." By an extension of this process a rule can be made by which multiplication and division can be done, just as addition and subtraction could be with two ordinary rules, were these processes long enough to require aid of this sort.

Incidentally, logarithms furnish a ready means of graduating such a rule so that the tedious cut-and-try method is unnecessary. However, let no one think that a knowledge of logarithms is necessary to work a slide rule. Almost any who will take a rule and follow the directions can work out the problems explained later whether he knows logarithms or not, and will find the slide rule a brain-and-time-saving shortcut for such work.

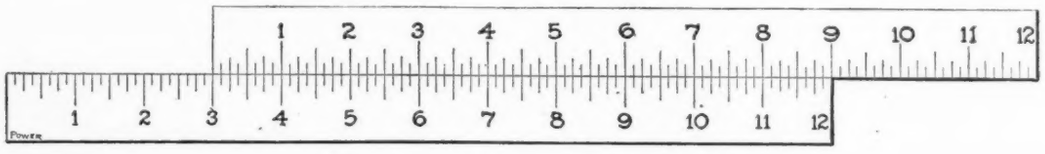


FIG. 1. ADDING WITH TWO RULERS

The ordinary rule, Fig. 2, consists of four scales, *A*, *B*, *C* and *D*, *B* and *C* being movable, *A* and *D* being fixed, and a runner with a hair line. The only difficulty in using the rule is to banish all disturbing thoughts about the decimal point. That is, the "1" of the slide rule represents 0.1, 1, 10, 100 or 1000; the "2" represents 0.2, 2, 20 or 200, etc. The decimal point is merely an incident; it is the absolute value of the figures that counts.

On the lower scales, *C* and *D*, it will be seen that the space from "1" to "2" is divided into 10 spaces, each of which is again subdivided into ten. The larger spaces represent "1.1," "1.2," "1.3," "1.4," etc., or these figures multiplied by 10 any number of times i.e.,; they may represent 1100, 1200, 1300, etc. The smaller spaces represent proportional parts of the larger divisions; thus the sixth line after the "1.2" line will be 1.26 (or 12.6, etc.).

If it is necessary, as it usually is, to estimate more closely, one must interpolate. That is, 1.005 would be got by setting the hair line of the runner halfway from "1" to the first line; 1.001 would be found by guessing at one-tenth of the first division; 1346 would be found by going up three of the main divisions from "1" to "2," giving 1300, then up four small divisions, giving 1340, then approximating six-tenths of the distance to the next line, giving approximately 1346.

The same is true with the higher numbers, "7" to "8," "8" to "9," etc., except that as will be seen by looking at the rule, the intervals between them are smaller, and there are on scale *D*, for instance, only 20 spaces between "9" and "10." It would, therefore, be necessary to estimate anything, except even twentieths, after the second figure here. Thus, 90.4 would be four-fifths of the distance from "9" to the first line after it.

The *A* and *B* scales on some rules are graduated from "1" to "10" and from "10" to "100." In others they run from "1" through "9" to "1" again and from "1" through "9" again to "1." The scales will, therefore, be referred to as the left-hand *A* scale, or to the left-hand "1," and the right-hand *A* scale, or the right-hand "1," although on some rules the right-hand "1" is marked "100." (Forget the decimal point.)

With this much preliminary, the best thing to do with a slide rule is to go ahead and use it, and learn by experiment. Multiplication is the easiest process. To multiply 1.3 by 3 on scales *C* and *D*, set the hair line of the runner over 1.3 on *D* and bring the left-hand "1" of *C* opposite it. The product (3.9) can then be read off on *D* opposite 3 on *C*.

There are numerous rules to keep the decimal point in mind as one works, but many find them all burdensome, and likely to be followed erroneously, and prefer to determine the decimal point after getting the answer, for it can usually be told whether an answer is 10 times too large or too small. Think of the slide rule as a person who would answer 8 whether he was asked what is 2×4; or 20×40; or 200×4000. So long as one knew of his personal peculiarity, and allowed for it, it would result in no difficulty. However, if one wants a rule for determining the decimal point, a fairly simple one is as follows:

In multiplication, if the slide projects to the left when the answer is found, add the whole-number places in the multiplicand and multiplier to get the number in the product. For division subtract the places in the divisor from those in the dividend to get those in the quotient. If the slide projects to the right when the answer is found, for multiplication do the same as before and then

subtract one, or, for division do the same as before and add one. In other words, add one less for multiplication and subtract one less for division.

It will be found by experiment that if the hair line of the runner be set on 3 of *D* and the left-hand "1" of *C* be placed opposite it, that 3.9 will be found opposite 1.3 on *C*, which is to be expected, as 2×3 is equal to 3×2. The following, then, may be given as a rule for multiplying on the slide rule:

Set the "1" of the movable scale opposite one of the numbers on the fixed scale; the product will be found on the fixed scale opposite the other number on the movable scale.

Study Questions

1. Using the slide rule, multiply 17,000 by 0.0093.
2. Divide 0.0316 by 273.
3. Solve $\frac{605 \times 921}{437}$.
4. Write the equation and solve with the slide rule the following problem. What is the horsepower of a 10x10-in. engine running at 346 r.p.m., when an indicator diagram shows a mean effective pressure of 26.7 lb.?
5. The heating surface of a boiler is 920 sq.ft. and the grate area 27 sq.ft. If the coal consumption is 10 lb. per sq.ft. of grate area, what is it per square foot of heating surface?

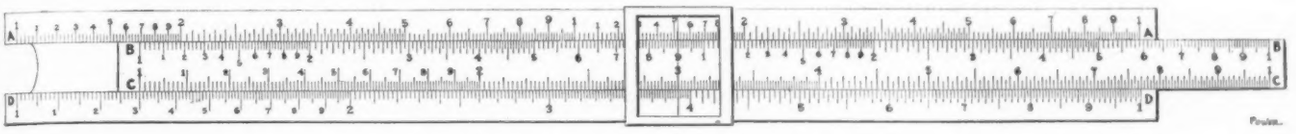


Fig. 2. The Slide Rule for Multiplying and Dividing

However, it may be noted that there is some mechanical choice in the above problem. If the smaller number be taken on the fixed scale, the slide projects less from the rule than if the larger number be taken there, and it will be found that the rule is less likely to be disturbed by accidental jolts, the less there is of the slide projecting.

As will be noticed as soon as any experimenting is done with the slide rule, the lower scales, *C* and *D*, are graduated more finely than *A* and *B*, or what is the same thing, the corresponding numbers are further apart. For this reason it is easier to read and interpolate on the lower scale, and in general it is preferable to use the lower scales for everything except roots and powers.

However, the lower scales have some unpleasant peculiarities. Suppose it is wished to multiply 2.6×45. If the hair line of the runner be set on 2.6 of scale *D*, and the left-hand "1" of scale *C* be brought opposite it, 45 on scale *C* will be found out in space. (Try this.) But this does not signify that 2.6 cannot be multiplied by 45 on scales *C* and *D*. Shift scale *C* end for end, setting the right-hand "1" (or ordinary "10," for they are the same on the slide rule) opposite 2.6 and opposite 45 on *C* is found 117 on *D*.

It may here be noted that the slide rule furnishes a set of tables. For instance, when the left-hand "1" of *C* is set on 26 of *D*, on *D* under the "2" of *C* is found 52, under the "3" of *C* is found 78. Resetting the rule, end for end; i.e., right-hand "1" of *C* on 26 of *D*, on *D* under "4" on C, is found 104, etc., i.e., a table of 26's is given in this way. This point will be reverted to later, but it should be seen immediately that if a larger number of multiplications are to be made, they can usually be performed with one setting of the rule, or at most two.

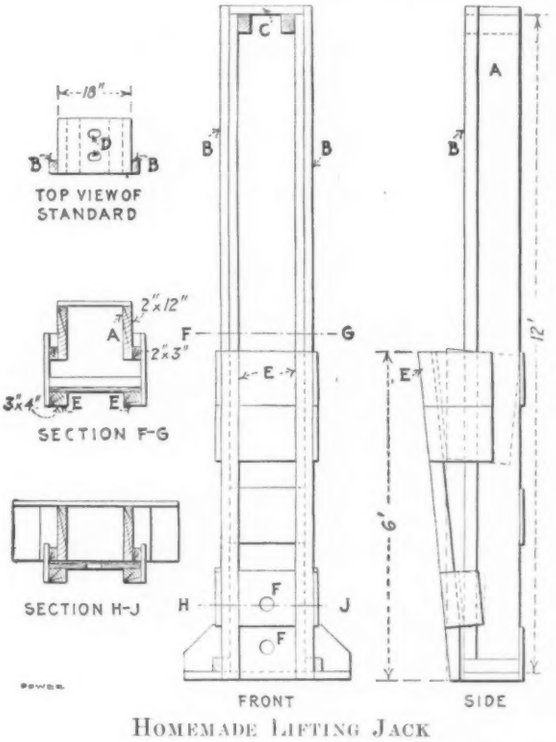
Division is the opposite of multiplication. To divide 962 by 37, on scale *D*, set the hair line of the runner on 96 and a little over, estimating two-fifths of the next small space; bring 37 on *C* opposite it. The quotient 26 will be found on the *D* scale opposite the "1" of the *C* scale.

In the next lesson will be explained how to get the squares and cubes, and the square roots and cube roots of numbers on the slide rule, with further hints on tables and on manipulation.

Handy Lifting Jack

By Robert C. H. Heck

Several years ago, the writer installed a small power plant in which the main piping was hung close to a low ceiling. This piping was made up ready for bolting together, the 5-in. high-pressure line with screwed-on flanges and flanged fittings; the 8-in. exhaust line (which had a number of branches) was in sections with flange unions. The heaviest sections ran from 500 to 800 lb.



Homemade Lifting Jack

in weight, and a one-ton triplex block had ample lifting capacity; but there was no head room in which the block could be hung above the position of the pipe to pull it up into place.

To meet this condition a special lifting jack was devised so arranged that it could be placed beneath the pipe and lift, the hoist block supplying the needed lift-

ing power. As outlined in the figure, it was made with an upright frame or standard *A*, made of two pieces of plank with crossbars at the top and bottom and some cross-bracing on the back below mid-height. Along the outer front edges were fastened two guide bars *BB* of light scantling. The hoist block was hung at *C*, by a rope sling through the holes *D* in the top of the crosspiece.

The slide *E*, the construction of which is evident from the drawing, can swing in against the standard (dotted position) or outward against the guides *BB* (full lines), when its top forms a projecting shelf upon which a load can be placed.

The scheme is to lay the section of piping in front of the jack and lift it from the floor by hooking into a rope sling around it. It is hoisted upward along the front of the slide *E*, which swings in so as to offer as little resistance as possible. When the pipe is above *E*, that lift is swung out and the pipe lowered upon it. Then the hoist chain is run down and hooked into a sling fast to the slide *E* at the holes *FF;* and by raising *E* the pipe can be lifted to or above the top of standard *A*, and held there till secured by its permanent fastenings and supports.

If the jack is leaned forward a little, there will be less drag against its front and it can be steadied by running a couple of light guy ropes back from the top to the nearest column, window or machine.

The real merit of the scheme is the combination of the partial plain lift from above, the remaining lift being beneath the load.

Superheating Steam in Locomotives

In a paper on the foregoing subject, presented before the Institution of Civil Engineers of Great Britain, by Henry Fowler, Jan. 13, 1914, it was stated that the chief advantage claimed for the use of superheated steam in locomotives is the economy in coal consumption. On the Midland Ry., a number of trials were made to ascertain what this is with the various types of engines, the comparison being made on the consumption per ton-mile under circumstances as nearly comparable as possible.

These trials show that a saving of 23 per cent. in the coal consumption and of 22 per cent. in the quantity of water used, was obtained in one case, while in another, where the difference between the locomotives was solely in the superheater, the saving of coal was as high as 30 per cent. This high figure was probably due to the engine which used superheated steam having more reserve of power than the one employing saturated steam. From diagrams of these two engines it can be shown very clearly how much more fluid superheated steam is than saturated.

Experiments have been carried out to ascertain the effect of superheating the steam supplied to the high-pressure cylinder of a three-cylinder compound locomotive, and it has been found that a saving of coal of 25.9 per cent. and of water of 22.3 per cent. has resulted when comparison is made with a similar engine using saturated steam. In tests carried out with freight engines, the coal saving has been from 14.3 to 18 per cent.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Sampson W. Moon has patented an electric safety razor. Great! Like his prototype of old, this modern Samson has t'run down the pillars of the Temple of Behindhand and boosted us old barnacles up into the light of progress—the Moon-light of progress, in a manner of speaking. Can we then be shaved in bed while we sleep, the operation being timed to completion when our alarm clock tolls the doleful hour of rising? How 'bout it, Sampy?

It's just as practical for the Navy to operate its own oil lands as for a railroad to operate its coal lands. Secretary Daniels may have trouble in finding available fields, but he's on the right trail.

Suggestion! Why not get Otto Edler von Graeve and his little guessing stick, the divining rod, to locate an oil field near a navy yard or a seacoast? Perhaps oil is not susceptible to the Edler's radioactivity, although oil waves flow up from underground—when found.

The Panama-Pacific Exposition buildings will need over a thousand tons of glass. My gollies! what if our suffragettes get the smashing habit along about 1915?

Our friend Vilhellum of Germany has sent his greetings over the 4062½ miles of wireless to Brother Wilson at Washington. The new Goldschmidt system wave speed is 196,000 miles per second. Some swift talk!

"Curing an Isolated Village of Loneliness," is the title of the leading article in the Jan. 29 "Iron Age." Sounds real good; but what's the remedy, importing a fresh load of eligible young bachelors or exporting the old maids? If any of the last-mentioned take exception to this harsh classification, we apologize here and now.

The Dodge Manufacturing Co. has a new (to us) dodge—it says it "treats an employee like a customer." President Melville W. Mix says "Bosh!" to the man who claims there's no sentiment in business. Here's another chance for that divining rod. How many employees expect or want such treatment? How many employers use it?

The most perfect pump in the world runs night and day without a stop, needs no repairs and lasts a lifetime; in an hour it pumps 956.25 lb., in a year 5,748,750 lb., its normal life is 70 years, in which it pumps more than 201,206 tons, and 30 engines would be required to haul that weight. It's the human heart.

Prizes of $120,000 will be awarded at Paris for the best stabilizer of air craft. Among the entries are the Sperry Gyroscope Co. and Glenn Curtiss. Here's hoping that the Yankees bring home the bacon! Anything that will make the airship stay up after it goes up, right-side up, can make the Parisians come up if it comes down right-side up.

A busy office manager has a miniature quilt of many colors on his desk, and when his eyes become tired from the white paper he rests his gaze on these colors. Wouldn't this carry you back to the quilts grandmother used to make?

They're a merry lot in Pittsburgh. The telephone folks are telling subscribers to "Smile when you phone; a frown has spoiled many a call." Let us assume, as Doc. Inquiries would say, that you met a chap you hadn't seen for years; and you just couldn't get away. You telephone the missus (and smile) that you're making a test at the plant that night; can't come home till 10:59. And friend Chap and you feed up, and take in a show, and then some more feed, then a bit of lubrication (and wifey, coming home from meeting, sees you going into the Café Mecca, the Beaux Arts, or Scully's (whichever you call it in your town) and then—About 10:58 you phone to the missus that the "test" is over—Smile? Wow! it can't be done.

The Induction Motor--VII

By F. A. Annett

The Repulsion Motor

From the general appearance of the windings, the stators of various repulsion motors are similar to that shown in Fig. 53, Part 6,* the number of poles being indicated by the winding itself.

The rotor has a winding similar to that of a direct-current machine; see Fig. 62, which shows the rotor of a Westinghouse repulsion motor. On this armature, however, the commutator is vertical and not horizontal, as in the direct-current machine. At starting, short-circuited brushes are pressed against the commutator, and after the motor has attained nearly synchronous speed a centrifugal governor, located within the armature, acts and presses a short-circuiting device against the commutator, short-circuiting all the armature coils. At the same time the brushes are raised from the commutator and the machine operates as a squirrel-cage induction motor.

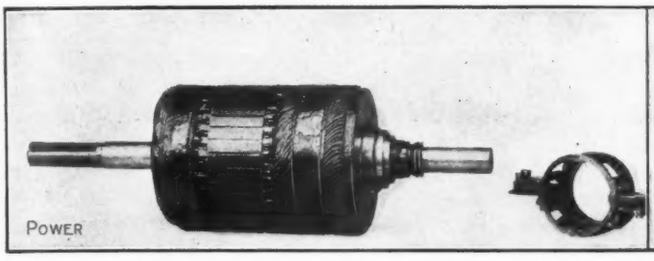


Fig. 62. Rotor of the Westinghouse Repulsion Motor

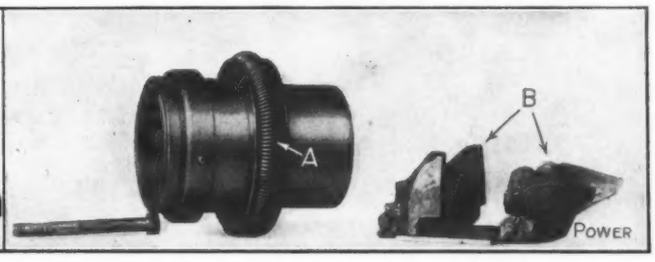


Fig. 63. Short-Circuiting Device and Governor Unassembled

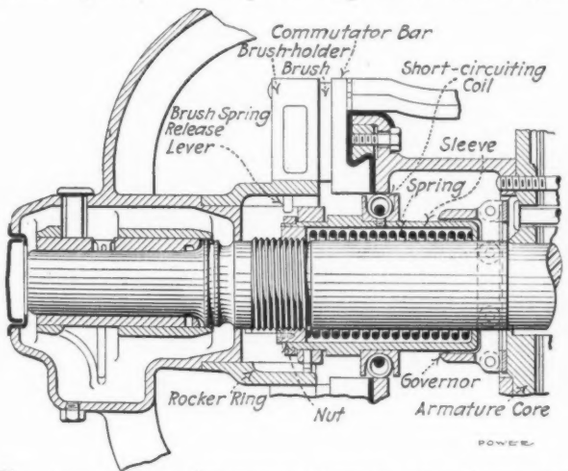


Fig. 64. Short-Circuting Device and Governor Assembled

Fig. 63, *A* and *B*, show the short-circuiting device and governor respectively. The short-circuiting device consists of a steel sleeve, carrying a short-circuiting coil or spring of helical phosphor-bronze inside of which is a ring of flexible copper shunts. The governor *b* is made up of two weights so hinged that they will be thrown apart by centrifugal force as the motor comes up to speed; it rests against the rotor core and is kept in place by dowels. The short-circuiting sleeve is pressed against the governor by a spring and the whole is retained in place by a nut threaded on the shaft. Fig. 64 is a cross-section through the commutator end of the rotor, indicating the position of the various parts. When the governor weights are thrown out from the shaft they will push the spring sleeve toward the commutator and with it the short-circuiting coil, which will be forced under the commutator, as previously described.

Fig. 65 shows the rotor of a Wagner single-phase repulsion induction motor. This also employs a vertical commutator and short-circuited brushes at starting. Part of the governor spring and the sleeve that raises the tension springs on the brushes, also the adjusting nut on the shaft, can be seen beyond the commutator. To operate the short-circuiting device and raise the brush springs, two types of governors are employed. On the small sizes, the governor consists of two semicircular disks mounted on the back end of the rotor. One end of these disks is made fast; the other is free to move through a slot as indicated in Fig. 66. These disks are so connected to the short-circuiting device that when they are thrown outward by centrifugal force they push the short-circuiting device out toward the commutator. On the large-size motors a governor is employed, as shown in Fig. 67. Two weights are mounted on the shaft within the rotor, and as the motor is accelerated, the weights are thrown outward, the effect being the same as described for the other governors.

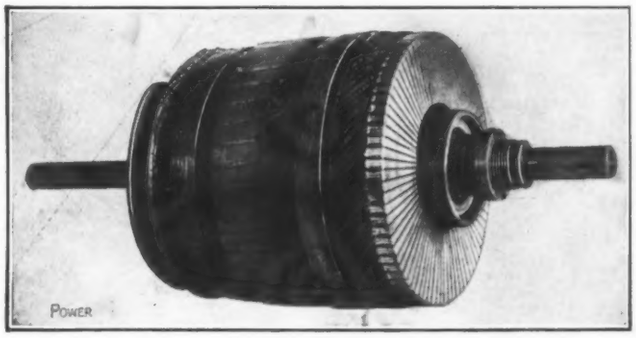


Fig. 65. Rotor of Wagner Motor

The Bell Electric Co. builds a repulsion motor with a horizontal instead of a vertical commutator; Fig. 68 shows the general appearance of the rotor. The governor and short-circuiting device are mounted at the outer end of the shaft. The governor *A* consists of two weights

*Jan. 20 issue.

connected to a collar, held in place by setscrews. The short-circuiting device *B* is a steel disk which can move freely on the shaft and when the rotor is at rest it is held away from the commutator by a spiral spring in a sleeve within the commutator. Inside the steel disk is mounted a thin phosphor-bronze radial ring, segmented on its inner edge and sprung away from the disk so that when forced against the commutator by the governor, when the motor comes up to speed, it will make good contact. In this type of motor the brushes are not raised from the commutator after the rotor has been short-circuited, but this is not necessary, for after the

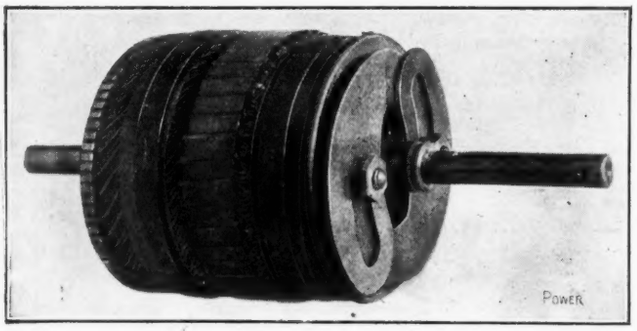


FIG. 66. SHOWING DISKS ON END OF ROTOR

commutator has been short-circuited the brushes cease to carry any current, and whatever sparking may have occurred at the brushes while starting will cease; therefore, the wear on the commutator is very small.

The motors just described, when connected directly to the line at rated voltage, start with 250 to 300 per cent. of full-load current and develop from 250 to 350 per cent. of full-load torque. Using a starting rheostat full-load torque can be developed with about 125 per cent. full-load current. As described in Part 6, by shifting the brushes to the right or left of the stator field axis, the direction of rotation is determined. The normal

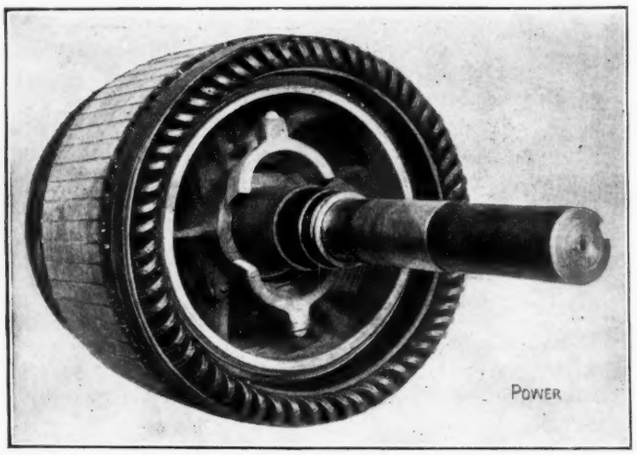


FIG. 67. GOVERNOR EMPLOYED ON LARGE MOTOR

running position for the brushes is when they are displaced from the stator field axis by about 15 or 20 electrical degrees. The position is always indicated by a scale, mounted on the rocker arm, with the two running positions indicated. If the motor is not turning in the proper direction, the brush-holder rocker arm should be shifted to the reverse position as indicated on the scale.

The repulsion motor, as described in Part 6, has series characteristics; that is, a variation through wide ranges of speed and torque from no load to full load. To overcome this, it is necessary to short-circuit the armature after the motor has come up to speed, thus converting

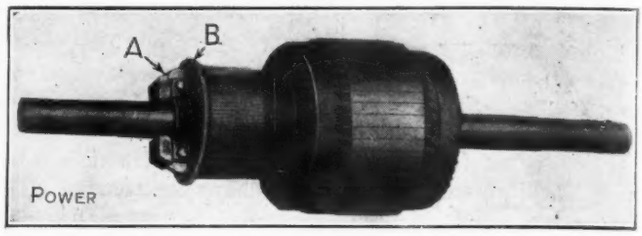


FIG. 68. ROTOR OF BELL MOTOR

the machine into one that has squirrel-cage characteristics or practically a constant speed from no load to full load.

By the addition of another set of brushes, *cd* Fig. 69, set 90 electrical degrees from the first set, the motor can be made to operate at practically constant speed, and the short-circuiting device can be dispensed with. Brushes *ab* are known as the energy brushes, and brushes *cd* as compensating brushes, and when both sets are in use there will be a resultant torque due to their combined action. With the brushes in the position shown, the action of brushes *ab* will be much greater than brushes *cd* and the direction of rotation will be as determined by the brushes *ab;* that is, the direction in which they are shifted with reference to the axis of the field poles. The no-load speed of this motor will be slightly above synchronism while the full-load speed will be below.

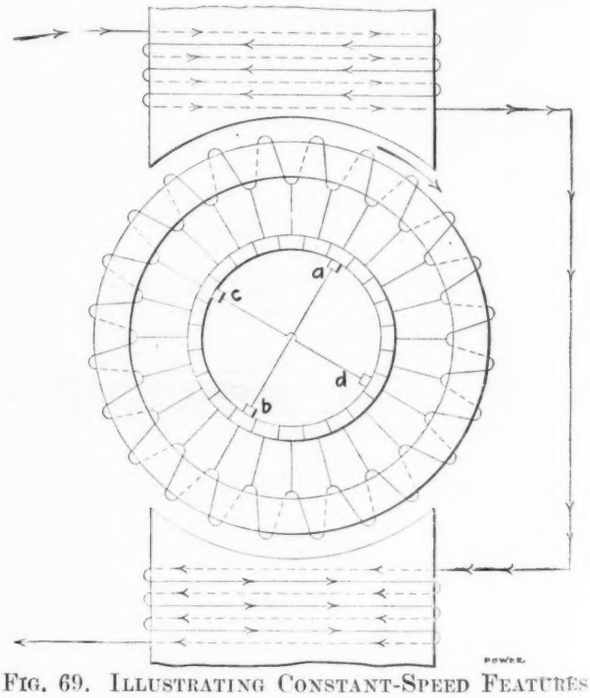


FIG. 69. ILLUSTRATING CONSTANT-SPEED FEATURES

By the addition of another winding concentric with the center portion of the main stator winding and connected with the compensating brushes *cd,* as shown diagrammatically in Fig. 70, the power factor may be increased to unity or above, which is a distinct advantage over the other types of induction motors, the power factor of which under the best conditions is usually never above 85 per cent.

The General Electric Co. builds a single-phase compensated repulsion induction motor of the same type as just described. The stator winding is shown in Fig. 56, Part 6. The compensating winding is auxiliary to the main stator winding and forms the center portion of the field-pole windings. Fig. 71 shows the armature used in this motor; the winding on the armature is of the series type connected to a horizontal commutator. A fan is mounted on the back end of the armature to improve the ventilation. When started, if this motor is connected directly to the line, it will develop 250 per cent. of full-load torque, and if started with a rheostat will develop full-load starting torque on about 200 per cent. of full-load current. To reverse the direction of rotation, shift the brushes to the opposite side of the stator field axis and interchange the compensating leads connected to the brushes. If the brushes are shifted and the leads of the compensating winding are not interchanged, the motor will emit a humming sound, develop a low starting torque and take an abnormally heavy current from the line, which will cause excessive heating of the field winding.

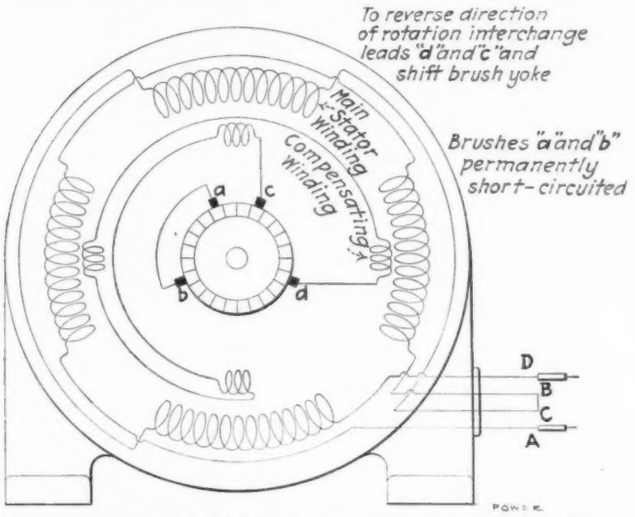


FIG. 70. WIRING DIAGRAM OF CONSTANT-SPEED MOTOR

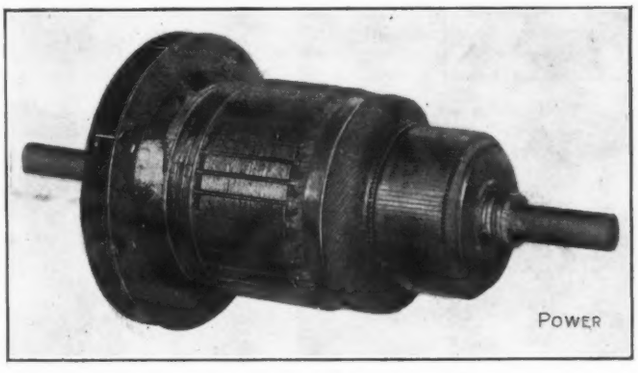


FIG. 71. COMMUTATOR END OF ARMATURE

A few years ago the Wagner Electric Manufacturing Co. brought out a new type of alternating-current compensated motor known as the unity power factor single-phase motor. This motor has approximately unity power factor at full load and a leading power factor at loads between full load and no load, decreasing to 60 per cent. leading at no load (see Fig. 72). However, this leading power factor can be used in most cases to compensate the lagging power factor of the generating plant and distribution system, thereby increasing the capacity of the plant and the line.

The construction of this motor is similar to the compensated motor previously described; the electrical connections are shown in Fig. 73. The stator winding has a main winding *a* and a compensating winding *b*. The chief departure is in the armature in which two windings are also used; the principal winding *c* is of the usual squirrel-cage type and occupies the bottom of the armature slots; auxiliary winding *d* occupies the upper part of the slots, is similar to that used in the machine previously described and is connected to a horizontal commutator. Between the two windings is a magnetic separator made of a soft rolled steel bar. Two sets of brushes are provided, the main pair of brushes (shown solid) is placed on the axis of the main stator winding, and is short-circuited, thus giving the repulsion-motor characteristics; the auxiliary pair is placed at right angles to the axis of the main stator winding and is connected in series with it. A cross-section of an armature slot is represented in Fig. 74.

During starting, switch *f*, Fig. 73, is open, and the compensating winding carries no current. The commutated winding *d* is in series with the main stator winding *a*. The commutated winding develops the torque at starting, and as the motor increases in speed the torque in this winding decreases very rapidly, but is more than offset by the torque developed in the squirrel-cage winding, which increases very rapidly, reaching a maximum at about 4 or 5 per cent. slip where it starts to decrease and becomes zero at synchronism. Above synchronous speed the torque in the squirrel-cage winding is reversed and it acts as a brake and balances the torque due to the series repulsion winding. The squirrel-cage winding, therefore, effectually prevents the motor from racing at light loads and gives it practically a constant speed be-

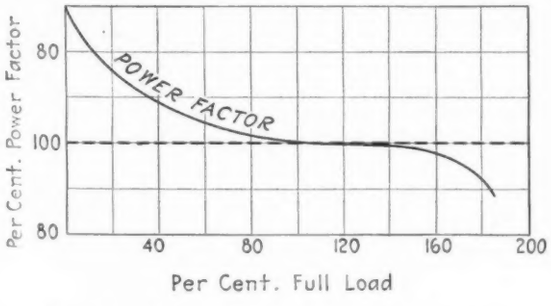


FIG. 72. VARIATION OF POWER FACTOR WITH LOAD

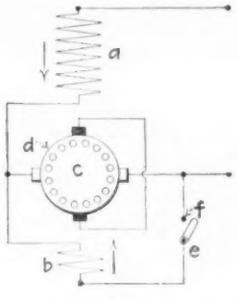


FIG. 73. DIAGRAM OF WINDING

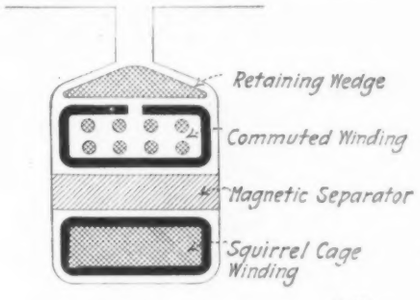


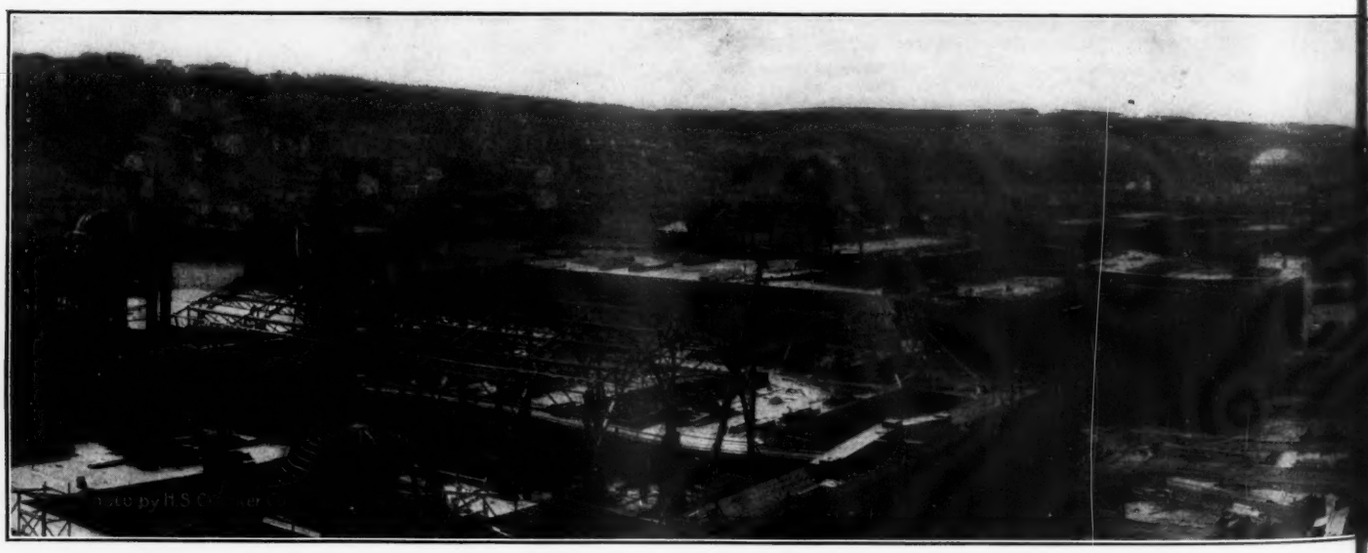
FIG. 74. ONE SLOT OF ROTOR, SHOWING CONSTRUCTION

tween no load and full load. The torque developed by the squirrel-cage winding is zero at starting, but increases very rapidly beyond a certain speed, which has the effect of giving the motor a speed torque which increases with the speed and insures the motor pulling through any load that it can start.

The magnetic separator acts as a shunt for the flux set up by the main stator winding at starting, and at the same time causes the inductance of the squirrel-cage winding to be high; consequently, the current set up in this winding is small at starting. As the motor speeds up this magnetic shunt effect is decreased by the action of the current in the squirrel-cage winding, and when near synchronous speed the machine operates practically in the same manner as if the magnetic separator did not exist at all. When the motor has reached nearly synchronous speed a small centrifugal switch *e*, located on the outer end of the armature shaft, is closed; this connects the auxiliary winding across the series brushes. This winding controls the power factor of the motor.

Progress of Panama-Pacific Exposition

The progress made in the construction of the Panama-Pacific International Exposition is clearly shown in the accompanying panoramic photograph taken from the roof of the completed Palace of Machinery, the largest wooden building ever erected.



A Panoramic View of the Panama-Pacific Grounds

The exceptional beauty of the site, fronting as it does for three miles on the bay of San Francisco within a stone's throw of the portals of the far-famed Golden Gate and with the evergreen hills of Marin on the opposite shore, is apparent.

In the background can be seen the Presidio, San Francisco's great army post, and to the extreme left, part of the residence district of the city. To the right is the Palace of Mines and Metallurgy, which is 60 per cent. complete; adjoining it on the left is the Palace of Varied Industries, also 60 per cent. complete. To the rear of these may be seen the Palace of Transportation, 50 per cent. complete, and behind that the Palace of Agriculture, 65 per cent. complete.

The building with the dome in the rear center is the Palace of Education, which is 90 per cent. complete, and in the fore of that the Palace of Liberal Arts, which is 60 per cent. complete. To the left and a bit forward is the Palace of Manufacture, 55 per cent. complete, and the site of the great Court of the Sun and Stars.

The rapidity of the progress made may be realized when it is understood that the first ground was broken for the palaces on Jan. 1, 1913.

Opening of the 201st St. Station, New York

New York's latest big power station was offcially placed in commission Jan. 31. It is the new generating station of the United Electric Light & Power Co., located at West 201st St. and the Harlem River. The purpose of the station is to supply the growing upper section of the city, and so it has been built to allow of additional equipment as the need arrives. At present it contains three 15,000-kw. turbo-generator units and has space for five more like them so that the building as it now stands represents a possible capacity of 120,000 kw. Reserve space is available in the same way for boilers, electrical wiring and equipment and panels on the switch and control boards for corresponding accessions of capacity.

In addition to the numerous individual invited guests, the opening ceremonies were witnessed by parties from the Brooklyn Engineers' Club and the Municipal Engineers of New York. The visitors, as they arrived at the Dyckman St. station of the subway were met by automobile busses and taken directly to the plant. There guides were appointed to take them by groups for an inspection of the plant. About 12:30 all congregated on the main floor to see the first unit started.

Luncheon was then served on the seventh floor of the building where addresses of welcome and brief histories of the enterprise were given by Frank W. Smith, vice-president of the United Electric Light & Power Co., and George B. Cortelyou, president of the Consolidated Gas Co., and one of the directors of the United company.

The building is fireproof, being of brick, steel and concrete throughout. It is seven stories high in the main part, although the equivalent height in the boiler section is divided into only two tiers. Above the boiler house is a 15,000-ton coal storage. The whole structure is 330x200 ft., and contains 200,000 sq.ft. of floor area. The four chimneys are each 22 ft. in diameter and 325 ft. high. On the several floors in the electrical-gallery section are the offices, busbar switches and reactance coils, busbar compartments, selector oil switches and feeder and generator switches.

All operations are directed from a control gallery on the second floor containing the generator benchboard and the semi-circular feeder-control boards, from which all switches are controlled. On the first floor is a storage battery and the generator rheostats.

On the street level (the basement) are the exciter-control board, exciters and transmission transformers. The 200-kw. exciters are directly connected to 7500-volt induction motors. The main turbine room is on the first-floor level, and beneath it is the auxiliary apparatus. All the steam auxiliaries are turbine-driven and the ventilating fans are motor driven.

On the first-floor level of the boiler house are thirty-two 650-hp. water-tube boilers, and space for an equal number is reserved on the second-floor level. Coal is delivered from the elevated bunkers to the automatic stokers that minimize the smoke by insuring practically perfect combustion, and the cinders are eliminated from the gases by furnace-gas cleaners.

From pockets under the boiler, ashes are transferred to cars hauled by electric mine locomotives and dumped into a hopper which feeds a skip hoist. This conveys them over the street to a hopper in a coal tower from which they are discharged into boats or carts. The coal tower is 240 ft. high and on the bulkhead at the water's edge to hoist coal as received on boats or barges and dump it into a hopper. From thence it passes through a crusher and into coal cars in which it is weighed. These cars are cable-hauled to the main building and dumped into the storage bunkers.

Conference of American Electric Railway Association

The midyear meeting of the American Electric Railway Association was held in New York on Jan. 29, 30 and 31. The first and third days were given up to committee meetings and on the evening of the 29th a banquet was held at the Waldorf-Astoria, about 800 attending.

Addresses were delivered by Charles N. Black, president of the association; C. S. Hawley, president of the American Electric Railway Manufacturers' Association; Guy E. Tripp, chairman of the board of directors, Westinghouse Electric & Manufacturing Co., and H. W. Anderson, vice-president and general counsel, Virginia Railway & Power Co. President Black decried the present system of public service supervision and announced that $100,000 was to be raised by the association to be devoted to a publicity campaign to counteract the popular demand for public utility regulation.

The general conference took place on Jan. 30, five papers being presented. Martin Schreiber discussed the value of the company sections and this was followed by a report of the special committee on the joint use of poles.

"The Economic Aspects of Regulation Compared with Profit Sharing with Municipalities" was the title of a paper by Halford Erickson, of the Wisconsin Railroad Commission. This discussed local versus state supervision and regulation, and also pointed out that one of the duties of a public service commission was to protect the public utilities' interests as well as the public's, for upon the former indirectly depended the ultimate service to the public. The other subjects discussed at the conference were "The Effect of Rate of Fare on Riding Habit," by F. W. Hild, L. R. Nash and S. G. McMeen, and "Influence of Labor on Legislation," by C. L. S. Tingley.

Civil-Service Opportunities

COMPETITIVE EXAMINATIONS *for the civil-service positions named below will be held on the dates given. Applications and further information may be had by addressing the respective commissions. Candidates must be citizens of the United States and residents of the cities in question, and at least 21 years of age, unless otherwise specified.*

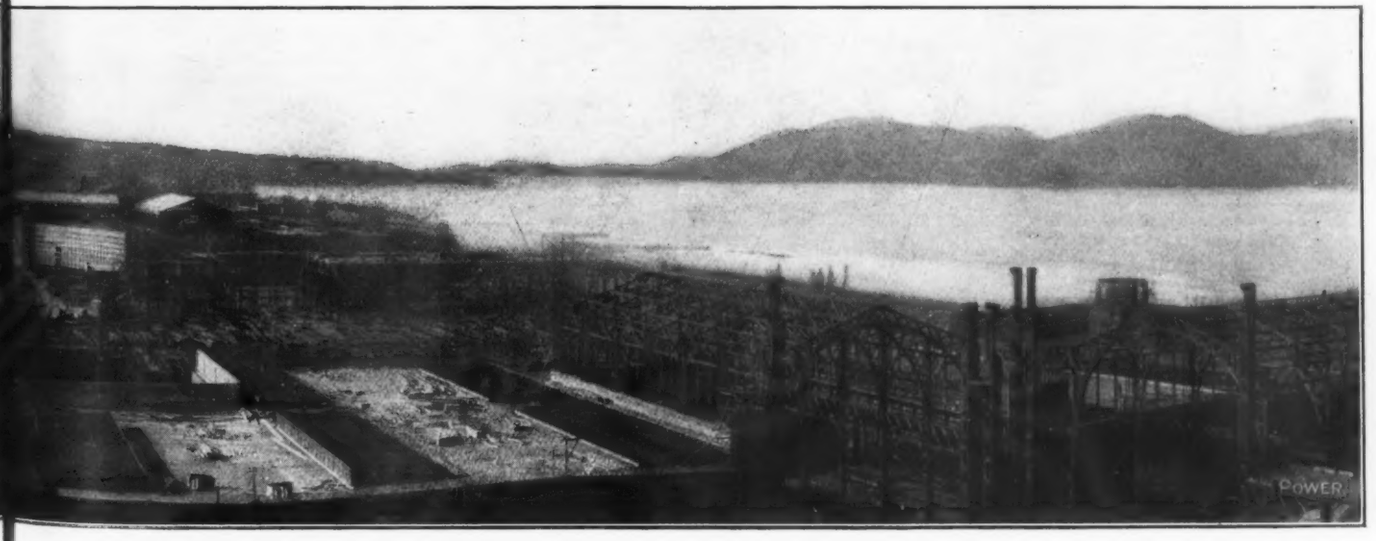
Assistant Steam Engineer—State and County Hospitals, Departments and Institutions. The New York State Civil Service Commission will hold an examination for this position, Feb. 21, 1914. Usual salaries $480 to $900 with maintenance when employed in institutions. Candidates, unless technical graduates, must have had two years' experience as machinists, boilermakers, steamfitters, oilers, firemen, engineers or electricians, including at least one year in the operation of steam engines or electrical machinery, which latter is also required of technical graduates also. Subjects of examination: Practical and technical questions on the operation and repair of steam engines, boilers, steam-heating apparatus and electrical machinery. Application blanks must be obtained by Feb. 11 and returned before Feb. 13. Address State Civil Service Commission, Albany, N. Y.

Diesel Engine Exhibit at Panama-Pacific Exposition

It is announced by the department of machinery of the Panama-Pacific International Exposition that since Jan. 1, more than 30,000 sq.ft. of exhibit space has been contracted for in the Palace of Machinery. More than a dozen firms have contracted for space in which to install engines built on the Diesel principle. These will occupy a central space in the Palace of Machinery, and will be under operation through connection with electric generators or other machinery to show the economy of working.

A large amount of exhibit space has also been spoken for by the manufacturers of steam turbines and unit type plants. In the electrical department there will be demonstrated the latest apparatus for the transmission and control of electric currents at high voltage.

New Federal Power Plant—Plans are now being drawn for a central power, light and heating plant in Washington to serve the group of Government buildings, including and adjacent to the White House and those on the opposite side of the Mall. The new plant will be located in the southwest section of the city, on the Potomac, and will probably have a capacity of about 6000 hp. Steam turbines will be employed and will run partly condensing (depending upon the heating demand), the exhaust being used for supplying steam and hot water to heat the buildings. L. B. Stillwell & Co., of New York, will do the engineering work.



SHOWING THE PROGRESS MADE IN BUILDING ERECTION

SOCIETY NOTES

The 35th annual entertainment and ball of Jersey City Association No. 1, N. A. S. E., was held on Friday evening, Jan. 30, at Elks Hall, Jersey City, N. J.

The Engineers Society of Western Pennsylvania elected the following officers Jan. 20: President, Albert R. Raymer; vice-president, Samuel E. Duff; treasurer, A. E. Frost; directors, George K. Neilson and Fred Crabtree. The membership is now 1124.

The Combined Associations, N. A. S. E., of Philadelphia, held their fifth annual entertainment and banquet at Lulu Temple, on Wednesday evening, Jan. 28. In the combined associations are Quaker City No. 1, Tacony No. 9, Merrick No. 12, and Northeast No. 20. A clever entertainment was given by national and local professional talent.

On Tuesday evening, Feb. 10, at 8:15 p.m., S. W. Dudley, assistant chief engineer of the Westinghouse Air Brake Co., will present a paper on "Brake Performance on Modern Steam Railroad Passenger Trains," at the meeting of the American Society of Mechanical Engineers, Engineering Societies Building, New York City. The data given are the result of tests made by the Pennsylvania R.R. in conjunction with the Westinghouse Air Brake Co. An informal dinner will be served at 6:30 p.m.

PERSONALS

John Beattie, formerly with the Consolidated Gas, Electric Light & Power Co., Baltimore, Md., is now chief engineer of the Metropolitan Life Insurance Co.'s Sanatorium, Wilton, N. Y.

Prof. J. Ansel Brooks will conduct the Brown University course in industrial organization and management. Prof. Brooks has been a member of the Brown faculty since 1903, and has been associate professor of mechanics and mechanical drawing since 1909. He was instructor in mechanical engineering at Yale from 1897 to 1901. His degrees are Ph. B., Yale, 1897, and M. E., Yale, 1901. He is a member of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education and the American Society for the Advancement of Science.

A. Reiche, formerly general manager of the Orenstein-Arthur Koppel Co., Koppel, Penn., sailed for Germany recently and has been succeeded by Erich Joseph, formerly the company's New York manager. Mr. Reiche has served for many years in the above capacity and under his supervision the plant has been greatly increased, with numerous branch offices in this country and in the West Indies. Mr. Reiche will assume the position of managing director for a large German manufacturer of locomobiles and agricultural machinery. Mr. Joseph has also been connected with the Orenstein-Arthur Koppel Co. for many years.

Prof. John Edson Sweet, the "Grand Old Man" of Syracuse engineering circles, was given the degree of doctor of engineering at the midwinter meeting of the board of trustees of Syracuse University. Prof. Sweet, who is president of the Straight Line Engine Co., was born in Pompey on Oct. 21, 1832. After a career in England he was professor of engineering at Cornell University. He is widely known throughout the country for his numerous inventions, among which are the oil ring in universal use for lubricating bearings, the matrix compositor, which was the first step toward the linotype machine, the Sweet ingot mold, governor and a measuring machine. He was one of the founders of the American Society of Mechanical Engineers and its third president. He is a charter member of the Technology Club and was its first president.

Joseph N. Gregory, for the last eight years Western New York manager of the Dearborn Chemical Co., is suggested by the Commissioner of Public Works for the new position of mechanical engineer in the Bureau of Buildings, Buffalo, N. Y. Mr. Gregory is an efficiency engineer, has a wide reputation, and is considered an expert in all matters allied with engineering problems.

Mr. Gregory was formerly president of the Marine Engineers' Association, New York branch, and has been president of the local body of the National Association of Stationary Engineers. At the time he assumed his present position he was vice-president of the State Association of Stationary Engineers. He is a member of the American Society of Mechanical Engineers, the American Railway Club, the Canadian Railway Club and various other mechanical and engineering societies throughout the country. For some time he was a member of the Civil Service Commission under Mayor Conrad Deihl of Buffalo. He is at present a member of the executive committee of the Board of Trustees of Locals 16 and 50 of the National Association of Stationary Engineers.

OBITUARY

WILLIAM COOPER

William Cooper, director of buildings and equipment at the Westinghouse Electric & Manufacturing Co., died Jan. 23. He was graduated from Cornell University in 1887 and became chief engineer of the Twin City Rapid Transit Co., St. Paul, Minn. Later Mr. Cooper was in the engineering department of the General Electric Co., at Schenectady. For six years he was chief engineer at the Bullock Electric & Manufacturing Co., at Cincinnati, leaving there to join the Westinghouse forces.

GEORGE J. WEBER

George J. Weber, inventor of a gasoline engine and former president of the Weber Gas & Gasoline Co., died recently at his home in Kansas City. Mr. Weber had more than forty patents granted to him covering nearly every phase of gas and gasoline engine construction. The turbine engine with which he was experimenting at the time of his injury will be completed by his sons.

He is survived by his wife, Mrs. Mary Louise Weber, and by four children, Edwin W., Lloyd H., Miss Cora Weber and Robert G. Weber, of New York.

JOHN C. KELLEY

John C. Kelley the founder and only president of the National Meter Co. for the past 44 years, died at his home, 247 Hancock St., Brooklyn, Jan. 24.

Mr. Kelley was born in Woodford, County Galway, Ireland, on Apr. 17, 1839. He came to this country with his parents when eight years old. His boyhood days were spent at Rochester and Palmyra, N. Y. From there his parents moved to Franklin, Ohio, and later to Cincinnati, where he was engaged in the retail dry-goods trade. On Jan. 1, 1860, he came to New York and entered into partnership with his uncle, the late Austin Kelley, in the manufacture of hoop skirts. On Sept. 9, 1860, he married Carrie A. Stuart, of New York.

Through an accident, Mr. Kelley met a man with a patent water meter, and on Jan. 5, 1870, he organized the National Meter Co., which he built up to a large and successful organization.

Mr. Kelley was prominent in the civic life of Brooklyn, and was identified with Loyola Union, Catholic Benevolent Legion, the Emerald Association, and many other organizations. During the first term of Mayor Low he was appointed to the old Brooklyn Board of Education

He was one of the charter members of the American Water Works Association. Among his friends who knew him well, he was known as a man of sterling integrity, remarkable firmness of character, and the tenderest sympathy for anyone in tronble. On account of his failing health Mr. Kelley withdrew from all outside organizations except the Home Trust Co., of which he was a director at the time of his death. He is survived by his widow, five daughters and two sons.

Novel Liquid Meter—The Leinert liquid meter automatically measures water, petroleum, sugar juice and other liquids, the measurements being made by weight and not by volume, therefore the temperature does not enter in. The meter has a pair of equal-sized tanks so arranged that when one is filled to standard level it automatically shifts the feed over to the second tank and is then emptied by siphon, recording at each time of filling and emptying. As this meter is actuated by the weight of the liquid, it is not subjected to the sudden inaccuracies of volume meters, and has scarcely any wearing parts. It can also be quickly cleaned and sterilized.—"Scientific American."

To Stimulate Internal-Combustion Turbine Development—It is proposed that England's Royal Automobile Club offer a prize for the most practical rotary or turbine oil or alcohol engine applied to a motor vehicle and entered for trial under the club's regulations in 1915. The amount of the prize has not been stated.